

FLUKE 341A + 343A

JOHN FLUKE MFG. CO., INC.

P.O. Box 7428 Seattle, Washington 98133


FOR REFERENCE PURPOSES ONLY

JUNE, 1969

MODELS 341A & 343A


DC VOLTAGE CALIBRATORS

CHANGE/ERRATA INFORMATION

MANUAL —  TITLE: MODELS 341A AND 343A DC VOLTAGE CALIBRATORS
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Please make changes in this manual according to the following change and/or errata information:

CHANGE # 1

On page 5-27 change flag note  to read as follows:

Q14, R21 and R24 are a factory selected and matched reference amplifier set. For Model 341A or 343A, replace the entire set, Fluke Part No. 4842-264051.

ERRATA

On page 1-1, paragraph 1-5, accuracy of output, change specifications to read as follows:

Model 341A:

| Range | Accuracy (whichever is greater) |
|-------|---|
| 10V | $\pm 0.005\%$ of setting or $\pm 0.0003\%$ of range |
| 100V | $\pm 0.005\%$ of setting or $\pm 0.0002\%$ of range |
| 1000V | $\pm 0.005\%$ of setting or $\pm 0.0002\%$ of range |

Model 343A:

| Range | Accuracy (whichever is greater) |
|-------|---|
| 10V | $\pm 0.002\%$ of setting or $\pm 0.0003\%$ of range |
| 100V | $\pm 0.002\%$ of setting or $\pm 0.0001\%$ of range |
| 1000V | $\pm 0.002\%$ of setting or $\pm 0.0001\%$ of range |

On page 5-17, change Q30 and Q31 from Mfgr. Part No. 40327 to 60994; change Q36 from Stock No. 4818-225599 to 4818-288761; change Q38 from Stock No. 4826-257121, Mfgr. 07263, Mfgr. Part No. FE0654C to Stock No. 4826-271924, Mfgr. 15818, Mfgr. Part No. U2427E.

On page 5-18, change Q43, Q45, Q47 and Q49 from Mfgr. Part No. 40327 to 60994.

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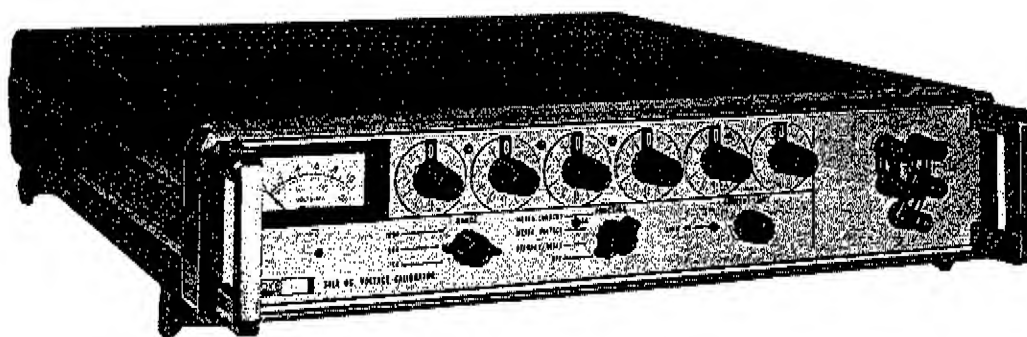
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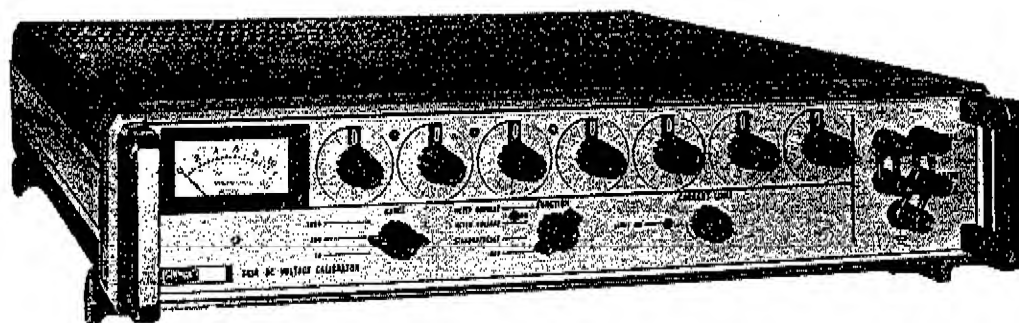
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341A
343A



MODEL 341A



MODEL 343A

DC VOLTAGE CALIBRATORS

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

1-2. The Fluke Model 341A and Model 343A DC Voltage Calibrators provide dc voltages of 0 to 1100 volts in three ranges. Voltages are selected by eleven-position decade switches, which provide in-line, digital readout of the instrument output voltage. The Model 341A employs six-dial readout, with 1 ppm resolution, and the Model 343A employs seven-dial readout, with 0.1 ppm resolution.

1-3. A controlled current limiter, a fixed current limiter, and an electronic crowbar circuit provide protection against instrument malfunction and operator error. Output current or voltage, depending on function desired, are continuously monitored by a front panel meter.

1-4. The instruments are designed for rack-mount installation, using the mounting brackets supplied, and are equipped with resilient feet and tilt-down bail for field or bench use.

1-5. ELECTRICAL SPECIFICATIONS

OUTPUT VOLTAGE

Model 341A: 0 to 1111.110 volts dc
Model 343A: 0 to 1111.1110 volts dc

VOLTAGE RANGES

| Model 341A: | Output (volts) |
|---------------|------------------------------|
| Range (volts) | |
| 10 | 0 to 11.11110 (10 uv steps) |
| 100 | 0 to 111.1110 (100 uv steps) |
| 1000 | 0 to 1111.110 (1 mv steps) |

Model 343A:

| Range (volts) | Output (volts) |
|---------------|-------------------------------|
| 10 | 0 to 11.111110 (1 uv steps) |
| 100 | 0 to 111.11110 (10 uv steps) |
| 1000 | 0 to 1111.1110 (100 uv steps) |

RESOLUTION

| | |
|-------------|---------------------------------|
| Model 341A: | 1 ppm of range (10 uv maximum) |
| Model 343A: | 0.1 ppm of range (1 uv maximum) |

ACCURACY OF OUTPUT

NOTE: The following accuracy specifications apply after (1 hour) warmup at standard reference conditions of 23°C ±5°C for the Model 341A and 23°C ±1°C for the Model 343A, up to 70% relative humidity, constant line voltage, and constant load.

Model 341A:

| Range | Accuracy (whichever is greater) |
|--------|--|
| 10 V | ±0.01% of setting or ±0.0003% of range |
| 100 V | ±0.01% of setting or ±0.0002% of range |
| 1000 V | ±0.01% of setting or ±0.0002% of range |

Model 343A:

| Range | Accuracy (whichever is greater) |
|--------|---|
| 10 V | ±0.003% of setting or ±0.0003% of range |
| 100 V | ±0.003% of setting or ±0.0001% of range |
| 1000 V | ±0.003% of setting or ±0.0001% of range |

TEMPERATURE COEFFICIENT OF OUTPUT

Model 341A: Less than (5 ppm of setting +0.1 ppm of range +2 uv) per °C from +15°C to +35°C. Less than (8 ppm of setting +0.1 ppm of range +2 uv) per °C from 0°C to +50°C.

341A
343A

Model 343A: Less than (3 ppm of setting +0.1 ppm of range +2 uv) per °C from +15° to +35°C. Less than (5 ppm of setting +0.1 ppm of range +2 uv) per °C from 0° to +50°C.

STABILITY OF OUTPUT

The following stability specifications apply at the standard reference conditions noted under ACCURACY OF OUTPUT:

Model 341A:

10V range (whichever is greater)
±0.0007% of setting or 5 uv per hour
±0.003% of setting or 15 uv per month

100V range (whichever is greater)
±0.0007% of setting or 10 uv per hour
±0.003% of setting or 25 uv per month

1000V range (whichever is greater)
±0.0007% of setting or 20 uv per hour
±0.003% of setting or 50 uv per month

Model 343A:

10V range (whichever is greater)
±0.0005% of setting or 5 uv per hour
±0.0015% of setting or 15 uv per month

100V range (whichever is greater)
±0.0005% of setting or 10 uv per hour
±0.0015% of setting or 25 uv per month

1000V range (whichever is greater)
±0.0005% of setting or 20 uv per hour
±0.0015% of setting or 50 uv per month

OUTPUT CURRENT

0 to 25 milliamps at any output voltage.

OVERCURRENT PROTECTION

Automatically limits output current at any present level between 1 and 25 milliamps via continuously variable front panel control. Panel lamp illuminates during limiting.

SHORT-CIRCUIT PROTECTION

At output voltage dial settings of 299.99X (299.999X on the Model 343A) or less, normal operation is restored upon removal of overload. At output voltage dial settings of 300.000 (300.0000 on the Model 343A) or above, the instrument trips to STANDBY when the output is short-circuited.

RIPPLE AND NOISE (all frequencies)

Model 341A:

60 Hz Line - Less than 100 uv rms or 1 mv p-p.
400 Hz Line - Less than 100 uv rms or 2 mv p-p.

Model 343A:

60 Hz Line - Less than 50 uv rms or 400 uv p-p.
400 Hz Line - Less than 100 uv rms or 2 mv p-p.

SETTLING TIME

Model 341A: Within 50 ppm of final output in 5 seconds.

Model 343A: Within 25 ppm of final output in 5 seconds.

LINE REGULATION

0.0005% of setting + 25 uv for a 10% line voltage change from nominal.

LOAD REGULATION

0.0005% of setting + 25 uv for a full load change.

ISOLATION

Either output terminal may be floated up to 500 volts dc from chassis ground.

REMOTE SENSE

Separate terminals are provided for sensing the output voltage directly at the load, thereby eliminating errors due to voltage drop in the instrument-to-load connecting wires.

WARM-UP TIME

Model 341A: Within 50 ppm of final output at turn-on.
Within 15 ppm of final output in 30 minutes.

Model 343A: Within 25 ppm of final output at turn-on.
Within 5 ppm of final output in 30 minutes.

INPUT POWER

115/230 volts ac ±10%, 50 to 440 Hz, single phase.
Approximately 70 volt-amperes fully loaded.

1-6. ENVIRONMENTAL SPECIFICATIONS

TEMPERATURE RANGE

Operating: 0° to +50°C
Storage: -40° to +65°C

RELATIVE HUMIDITY

0 to 70%

SHOCK

Withstands 15 g, 11 millisecond, half sine wave shock per MIL-T-21200.

VIBRATION

Withstands 10 Hz to 55 Hz, 4.5 g maximum per MIL-T-21200.

ALTITUDE

Up to 10,000 feet operating and 50,000 feet non-operating, per MIL-T-21200.

1-7. MECHANICAL SPECIFICATIONS

SIZE

3½ inches high by 17 inches wide by 18 inches deep.

MOUNTING

Mounting brackets provided for standard EIA 19-inch rack mount, and resilient feet provided for bench use. Tapped

holes also provided for attaching chassis slides. The instrument outline drawing is shown in Figure 1-1.

WEIGHT

23 pounds

1-8. GENERAL SPECIFICATIONS

DESIGN

Solid-state throughout

FUSES

Single-fused ac line and high voltage

METER

Monitors output voltage and current

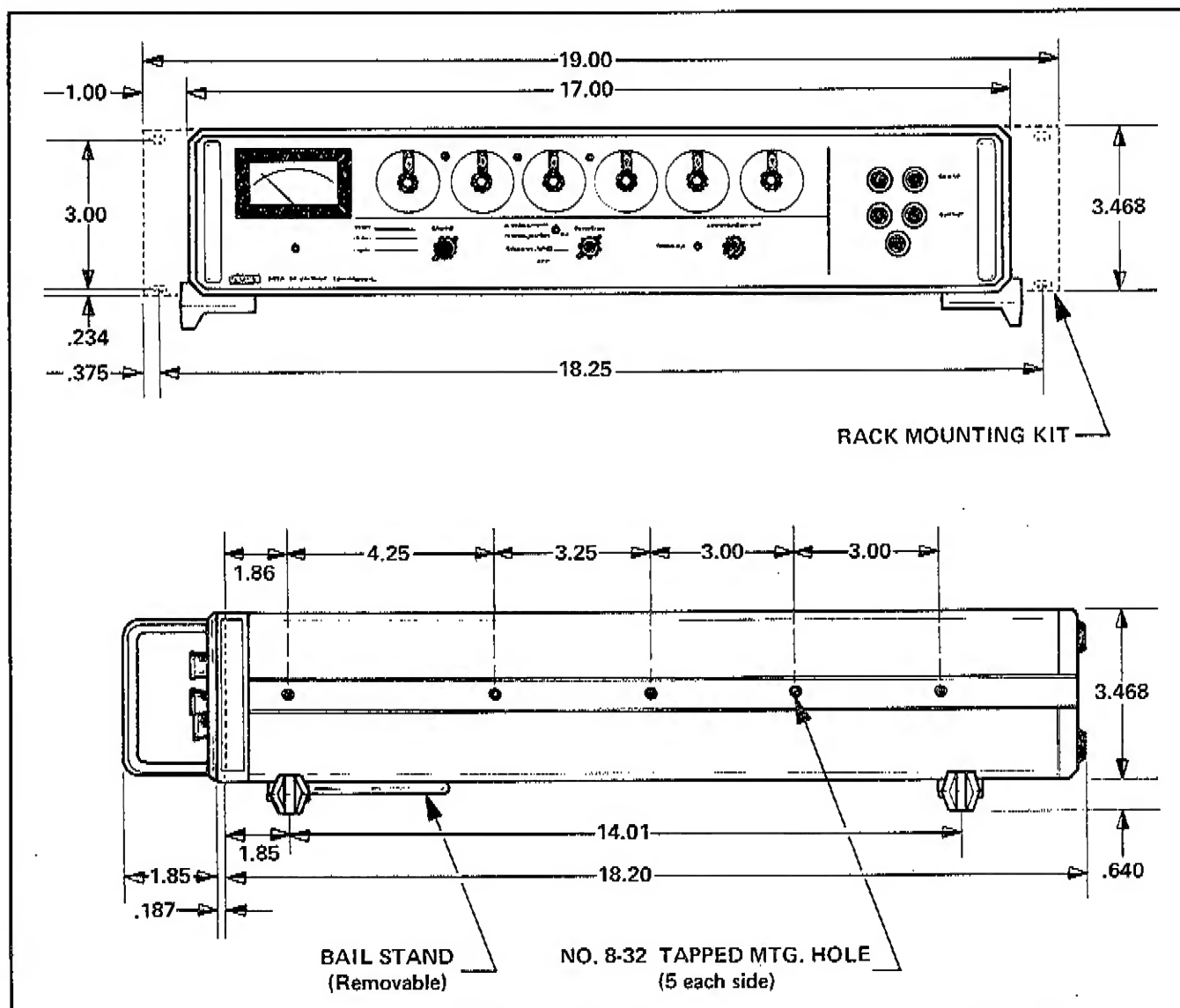


Figure 1-1. MODEL 341A/343A OUTLINE DRAWING

SECTION II

OPERATING INSTRUCTIONS

2-1. INTRODUCTION

2-2. This section contains operating instructions and applications information for the Model 341A and Model 343A Voltage Calibrators. Unless otherwise specified, all instructions apply to both instruments.

2-3. If any problem is encountered in operating the instrument, contact the nearest John Fluke Sales Representative or write directly to the John Fluke Manufacturing Company. Please include the instrument serial number when writing.

2-4. OPERATING FEATURES

2-5. The following paragraphs describe instrument controls and power requirements.

2-6. CONTROLS, TERMINALS, AND INDICATORS

2-7. The name and function of the front and rear panel controls, terminals, and indicators are shown in Figure 2-1.

2-8. INPUT POWER REQUIREMENTS

2-9. The instrument operates on either 115 or 230 volt ac power, and is normally supplied with connections for 115 volt use. Dual primary windings in the power transformer permit ready conversion from one operating voltage to the other. The conversion procedure is described in section IV, paragraph 4-18.

2-10. PRELIMINARY OPERATION

2-11. The following paragraphs describe preliminary connections, control settings, adjustments and safety precautions, which should be observed before operating the instrument.

2-12. AC LINE CONNECTIONS

2-13. Connect the Model 341A/343A line plug to a 115 volt ac (or to 230 volts ac if the instrument is so wired), 50 to 440 Hz, single phase, three-wire outlet.

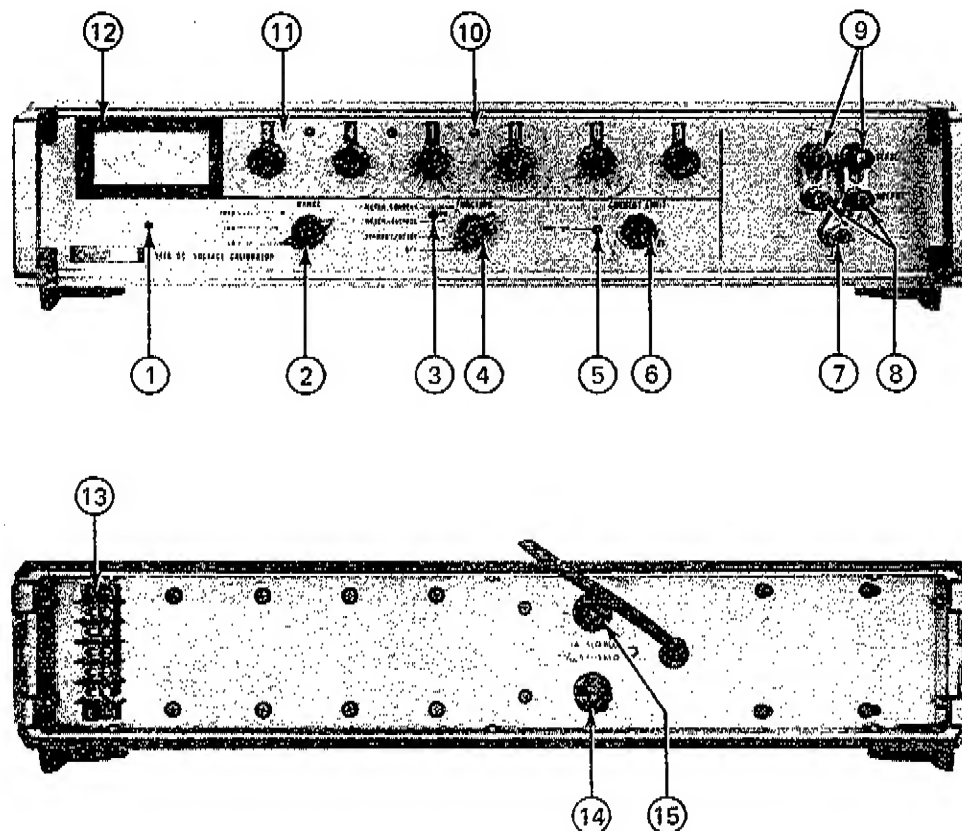
WARNING!

The round pin on the polarized three-prong plug connects the instrument case to power system ground. Verify that the ac outlet is provided with the earth ground wire normally found in a three wire single-phase connector. If the third wire is not present in the outlet or if a three-to-two-wire adapter is used, ensure that the instrument ground wire is connected to a high quality earth ground.

2-14. SENSE CONNECTIONS

2-15. When a load is connected to the Model 341A/343A, there may be an appreciable voltage drop between the instrument and the load due to the resistance of the connecting leads. The nomograph shown in Figure 2-2 can be used to determine the approximate voltage developed in the leads. If the voltage drop is excessive, the instrument can then be connected for remote sensing.

2-16. **Using The Nomograph.** With a straight edge, connect the point representing output current on scale 1 to the point representing the gauge of the connecting wires on scale 2. The voltage developed in the connecting wires, expressed in millivolts per foot, is read on scale 3. To determine the total voltage developed in the connecting leads, multiply the total length in feet by the value obtained from scale 3. For example, assume that two AWG



| REF. NO. | NAME | FUNCTION |
|----------|------------------------|---|
| 1 | Mechanical zero adjust | Sets the meter mechanical zero. Adjust only after instrument has been turned off for at least 3 minutes. |
| 2 | RANGE switch | Selects one of three full-scale voltage ranges: 10, 100 or 1000 volts dc. |
| 3 | Power ON indicator | Illuminates when instrument is fully operable. |
| 4 | FUNCTION switch | Controls instrument input power and output monitoring functions. In STANDBY/RESET position, all circuitry except the high voltage power supply is energized. In power ON position, the instrument is fully operable. When instrument is ON, output voltage is monitored in METER VOLTAGE position and output current in METER CURRENT position. |
| 5 | LIMIT ON indicator | Illuminates when the controlled current limiter is activated. When lit, output current is limited to a preset value. |

Figure 2-1. CONTROLS, TERMINALS AND INDICATORS (Sheet 1 of 2)

| REF. NO. | NAME | FUNCTION |
|----------|-----------------------|--|
| 6 | CURRENT LIMIT control | Sets operating point of controlled current limiter, which limits maximum output current to any value from zero to about 25 milliamps. |
| 7 | Ground Terminal | Connection for grounding either positive or negative OUTPUT terminal to power line ground. |
| 8 | OUTPUT terminals | Output voltage connections, with both terminal isolated from instrument case and power line ground. Terminals may be floated up to 500 volts dc from chassis. |
| 9 | SENSE terminals | Direct connection to instrument regulating circuitry. Connected to OUTPUT terminals or remote load to provide optimum load regulation. |
| 10 | Decimal lamps | Indicate location of decimal point for voltage dial readout, and are controlled by the RANGE switch. |
| 11 | Voltage dials | Six voltage dials (seven dials on the 343A) set output voltage and provide in-line digital readout from 0 to 1111.110 volts dc (0 to 1111.1110 volts dc for the Model 343A). A dial set to "X" (10) represents 0 with a carry of 1 to the left, thus 11.1110 would be dialed as 10.XXXXX. NOTE: In dial readout notation, the underscore (10) denotes a single dial that is displaying two significant digits. |
| 12 | Meter | Indicates OUTPUT voltage or load current, depending on setting of FUNCTION switch. The meter voltage range corresponds to the setting of the RANGE switch. Voltage is indicated on a 0 to 10 scale, with 10% over-ranging. The meter current range is fixed at 0 to 30 milliamps. NOTE: Meter current includes beta string current. This introduces a small error, which is negligible on the 10 and 100 volt ranges; in the 1000 volt range, the error will be equal to + 1 milliamp. |
| 13 | Terminal strip | Provides output, sense, and ground connections for rack-mount installations. Standard on the Model 343A and option only on the Model 341A. |
| 14 | Fuse, high voltage | High voltage power supply output fuse, rated at 1/16 amp, slow blow. |
| 15 | Fuse, line | Power line fuse, 1 amp slow blow for 115 volts ac operation and 1/2 amp slow blow for 230 volts ac operation. |

Figure 2-1. CONTROLS, TERMINALS AND INDICATORS (Sheet 2 of 2)

No. 28 wires, each 3 ft long, are used to connect a load, requiring 25 milliamps to the OUTPUT terminals of the Model 341A/343A. With a straight edge, connect the known current on scale 1 (25 ma) and the wire size on scale 2 (No. 28). The resulting IR drop on scale 3 is

approximately 1.65 millivolts per foot. Therefore, the connecting wires develop a total voltage of 12 millivolts ($2 \times 3\text{ft} \times 1.65 \text{ mv/ft} = 9.9 \text{ mv}$), which is more than one and one-half times the published load regulation of the instrument at 1000 volts output. To compensate for this,

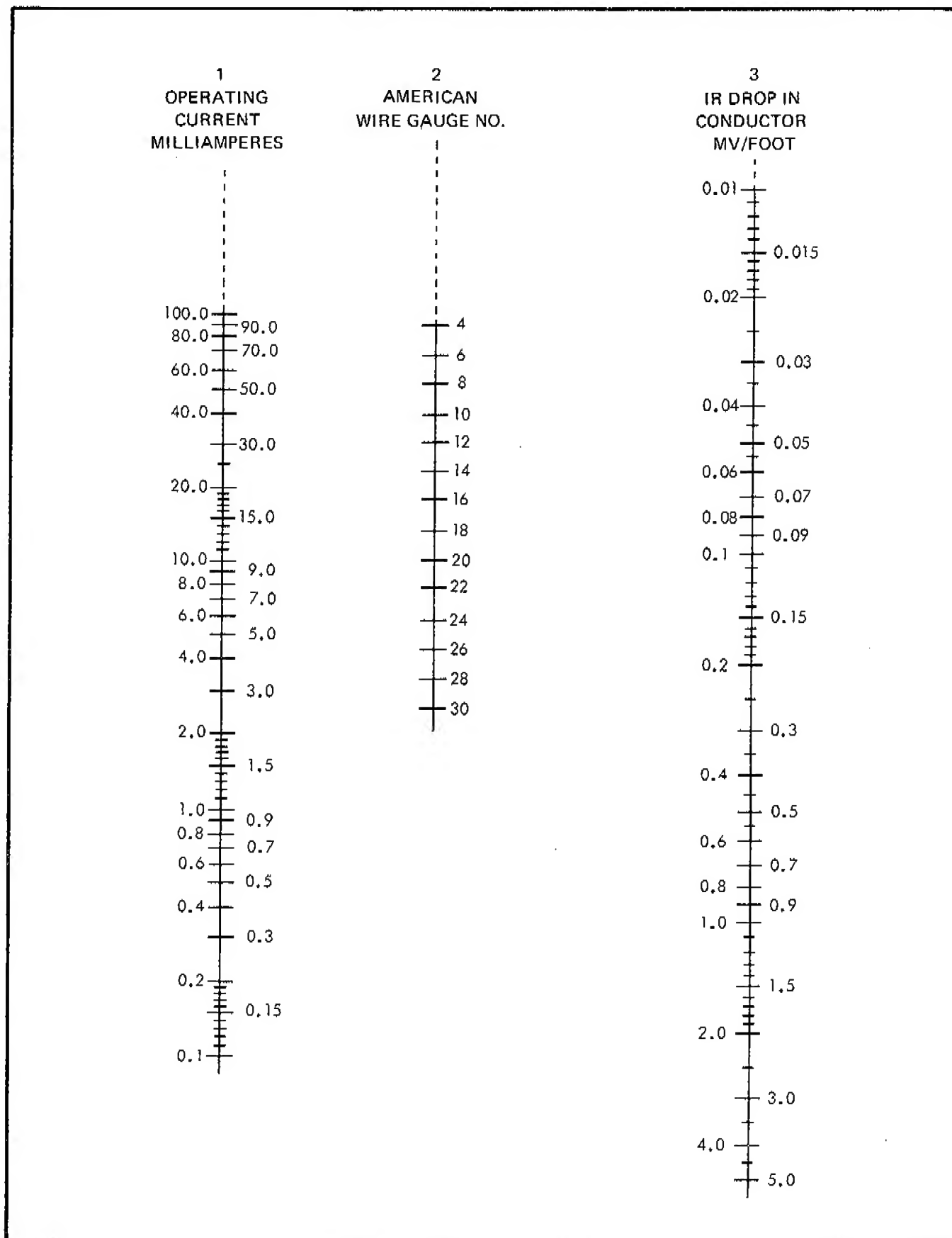


Figure 2-2. NOMOGRAPH OF VOLTAGE DROP IN LOAD WIRES

the Model 341A/343A is equipped with remote sensing, which maintains regulation at the load independent of lead length.

2-17. Remote Sensing. If the voltage developed in the load connecting leads is found to be excessive, proceed as follows:

- a. With the FUNCTION switch set to OFF or to STANDBY/RESET, remove the front-panel shorting links between the SENSE and OUTPUT terminals.
- b. Using a twisted pair of insulated wires, connect the + SENSE terminal to the positive side of the load, and connect the - SENSE terminal to the negative side of the load.

CAUTION!

Ensure that the SENSE terminals are connected to the load in the proper polarity. Incorrect connections will result in loss of regulation and possible damage to the instrument. When remote sensing is not used, the SENSE terminals must be connected to the OUTPUT terminals with the front-panel shorting links.

2-18. CURRENT LIMIT OPERATION

2-19. The CURRENT LIMIT control sets the operating point of the controlled current limiter, which limits the instrument output current to any value between 1 and 25 milliamperes. The approximate value of limiting current is indicated by a 1 to 25 scale circumscribed about the CURRENT LIMIT control on the front panel. If no current limiting is desired, set the CURRENT LIMIT control fully clockwise (25). In this position, maximum instrument output current is available at all voltage settings. If some degree of current limiting is desired, proceed as follows:

- a. Set the Model 341A/343A control as follows:

| | |
|---------------|-----------------------|
| FUNCTION | STANDBY/RESET |
| RANGE | 10 |
| Voltage dials | 1.00000 (Model 341A) |
| | 1.000000 (Model 343A) |
| CURRENT LIMIT | Fully clockwise |
- b. Place a short across the + and - OUTPUT terminals.
- c. Set the FUNCTION switch to METER CURRENT.
- d. Set the output current limit by rotating the CURRENT LIMIT control counterclockwise until the panel meter indicates the desired limiting current.

- e. Set the FUNCTION switch to STANDBY/RESET and remove the short from across the OUTPUT terminals.

2-20. OVERLOAD PROTECTION

2-21. The Model 341A/343A is automatically protected against current overload, and a continuous short circuit will in no way harm the unit. At output voltage dial settings of 299.99X (299.999X on the Model 343A) or less, the output voltage will return quickly upon removal of the overload. At voltage dial settings of 300.000 (300.0000 on the Model 343A) and above, a short circuit at the output will trip the instrument to STANDBY. Trip is evidenced by illumination of the CURRENT LIMIT lamp and extinction of the ON lamp. After the overload condition is corrected, the instrument may be reset by setting the FUNCTION switch to the STANDBY/RESET position momentarily and then back to ON.

2-22. Output voltages are fully controlled when downranging or switching to STANDBY. This is accomplished by a pair of crowbar relays, which discharge the high voltage filter capacitors in a series of steps. The action of the crowbar relays is very rapid and is audible to the user. When downranging from the 1000 volt range (500 to 1000 volt dial settings) to the 100 or 10 volt ranges, crowbar operation can be heard as a rattle as the switch position is changed. The crowbar circuit provides continuous protection as long as downranging is not excessive; however, if downranging occurs consistently at intervals less than 5 seconds, the instrument will automatically trip to STANDBY.

2-23. MECHANICAL ZERO ADJUSTMENT

2-24. When necessary, mechanically zero the meter with the adjustment screw on the front panel. If the instrument has been operating, it must be turned off for at least 3 minutes prior to this adjustment.

2-25. OPERATION AS A VOLTAGE CALIBRATOR

2-26. To use the Model 341A/343A as a voltage source, proceed as follows:

- a. Set the FUNCTION switch to STANDBY/RESET. Allow at least a 10-minute warm-up period if the instrument has just been energized.
- b. Connect the SENSE terminals to the OUTPUT terminals with the shorting links provided and connect the load. If remote sensing is desired, connect the SENSE terminals to the load as described in paragraph 2-17.

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- c. Set the CURRENT LIMIT control fully clockwise (25) or to a predetermined value, using the procedure of paragraph 2-17.
- d. Set the RANGE switch and voltage dials to the value of the desired output voltage.
- e. Set the FUNCTION switch to ON.
- f. The output voltage delivered to the load will correspond to the voltage indicated on the voltage dials. To monitor output voltage or current, place the FUNCTION switch in either the METER VOLTAGE or METER CURRENT position.

2-27. APPLICATIONS

2-28. The Model 341A/343A Voltage Calibrators provide parameters of stability, accuracy, temperature coefficient and response required by a broad range of laboratory and production applications. The following paragraphs describe a method of using the instrument as a differential voltmeter and, in conjunction with a reference divider, as a precision voltage source with traceability to the National Bureau of Standards.

2-29. OPERATION AS A DIFFERENTIAL VOLTMETER

2-30. The Model 341A/343A can be used in combination with a null detector, such as the Fluke Model 845AB, as a differential voltmeter. Connection of the equipment for measurement of a positive voltage is shown in Figure 2-3. Proceed as follows:

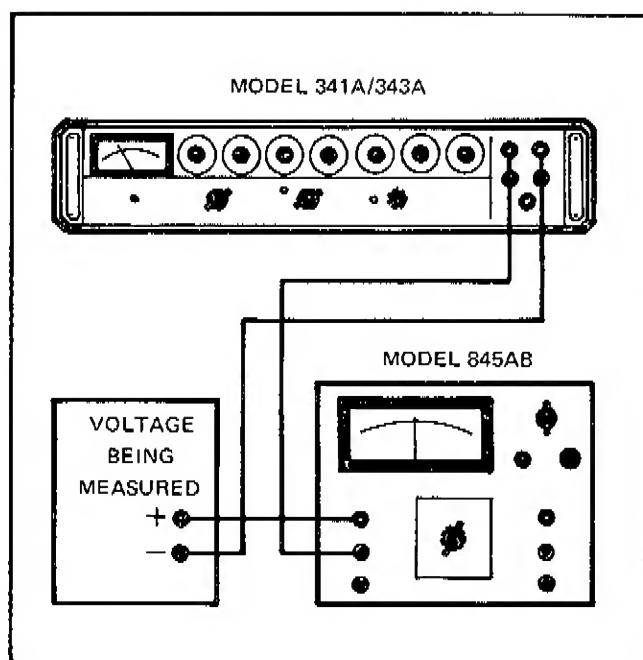


Figure 2-3. DIFFERENTIAL VOLTMETER

- a. Connect the null detector INPUT terminal to the positive terminal of the voltage to be measured, and connect the null detector COMMON terminal to the Model 341A/343A + OUTPUT terminal. Connect the Model 341A/343A - OUTPUT terminal to the negative side of the voltage being measured.

WARNING!

To eliminate shock hazard, leave the ground terminals of the Model 341A/343A and null detector disconnected.

- b. Set the null detector voltage range and Model 341A/343A voltage dials to approximately the voltage being measured. If the voltage being measured is not known, set the null detector to the 1000 volt range initially.
- c. Set the Model 341A/343A FUNCTION switch to ON, and set the CURRENT LIMIT control as desired.
- d. Set the Model 341A/343A RANGE switch and voltage dials to the approximate voltage indicated by the null detector. The null detector should then indicate a null.
- e. Set the null detector for increased sensitivity, and adjust the voltage dials for zero deflection on the null detector.
- f. The value of the voltage being measured is indicated by the Model 341A/343A voltage dial setting at zero deflection of the null detector.
- g. To measure a negative voltage, reverse the connections at the Model 341A/343A OUTPUT terminals.

2-31. OPERATION AS A 10 PPM SOURCE

2-32. The Model 341A/343A together with a reference divider such as the Fluke Model 750A can provide voltages of 0.1, 0.5, 1, 1.1, 5, 10, 50, 100, 500, 1000, and 1100 volts dc, which have an accuracy of 10 ppm and are traceable to the National Bureau of Standards. Equipment connection is shown in Figure 2-4. Proceed as follows:

- a. Set the Model 750A input switch to RESET. Adjust the Model 341A/343A CURRENT LIMIT control for 2 milliamps, using the procedure of paragraph 2-18.
- b. Set the Model 341A/343A FUNCTION switch to STANDBY/RESET. Set the Model 750A standard cell voltage dials to the voltage of the standard cell.

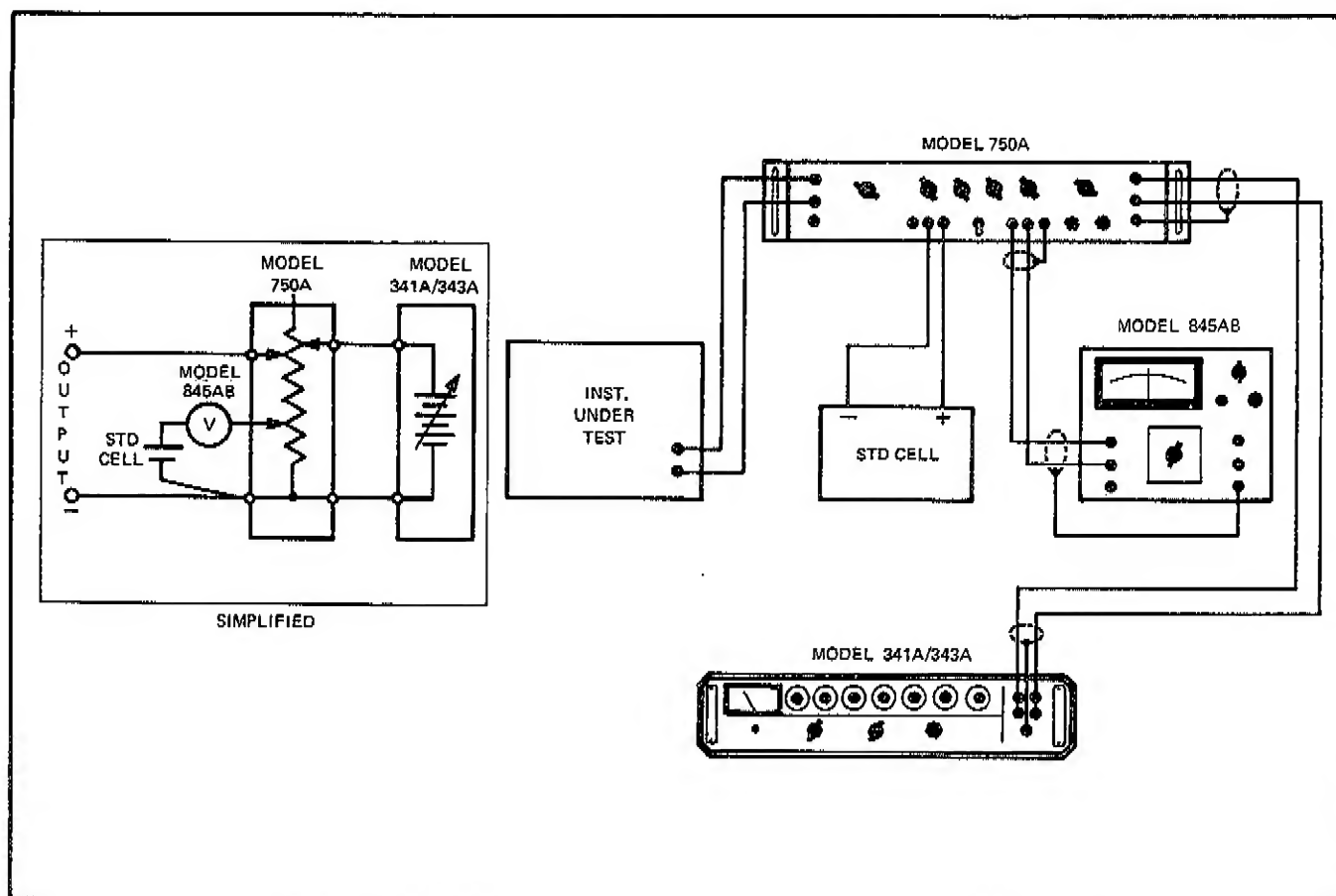


Figure 2-4. OPERATION AS A 10 PPM SOURCE

- c. Set the input voltage switch of the Model 750A as desired. Set the Model 341A/343A output to the same voltage.
- d. Set the Model 341A/343A FUNCTION switch to ON and set the Model 845AB for 100 microvolts sensitivity.
- e. Adjust the voltage dials of the Model 341A/343A and the coarse and fine dials of the Model 750A for a null on successively more sensitive null ranges of the Model 845AB. Final null should be on the 10 microvolt range.
- f. The output voltage of the Model 750A corresponds to the output voltage switch setting.

SECTION III

THEORY OF OPERATION

3-1. INTRODUCTION

3-2. The following paragraphs describe the theory of operation of the Model 341A and 343A Voltage Calibrators. For the block diagram analysis, refer to the block diagram shown in Figure 3-1, and for the detailed circuit analysis, refer to the detailed circuit schematic at the end of Section V.

3-3. BLOCK DIAGRAM ANALYSIS

3-4. The instrument circuitry is basically that of a high gain operational amplifier, as shown in Figure 3-2. The driving signal is generated in a precision voltage reference and applied through a range control network to the amplifier input. The series regulator, which is the output stage of the amplifier, provides the high voltage capability.

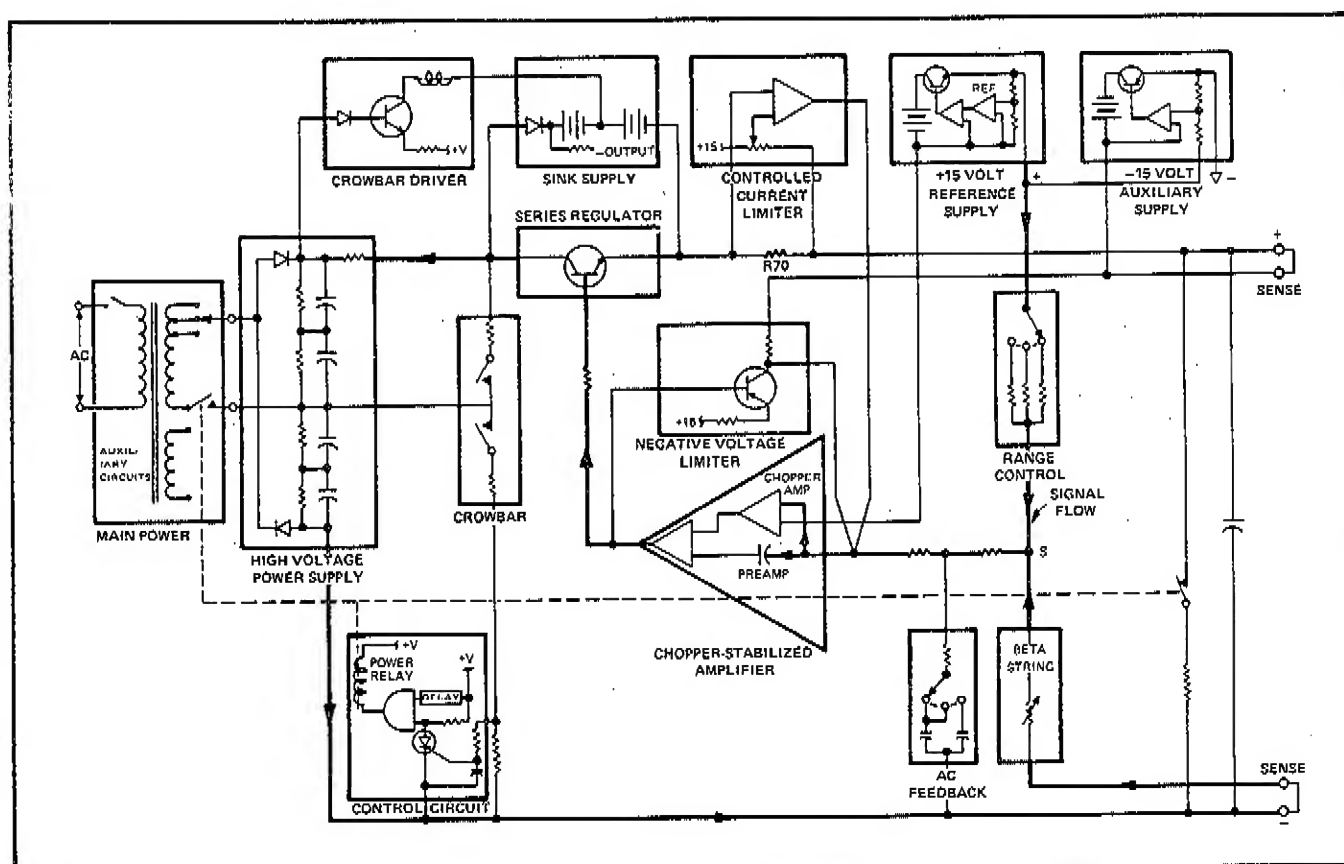


Figure 3-1. MODEL 341A/343A BLOCK DIAGRAM

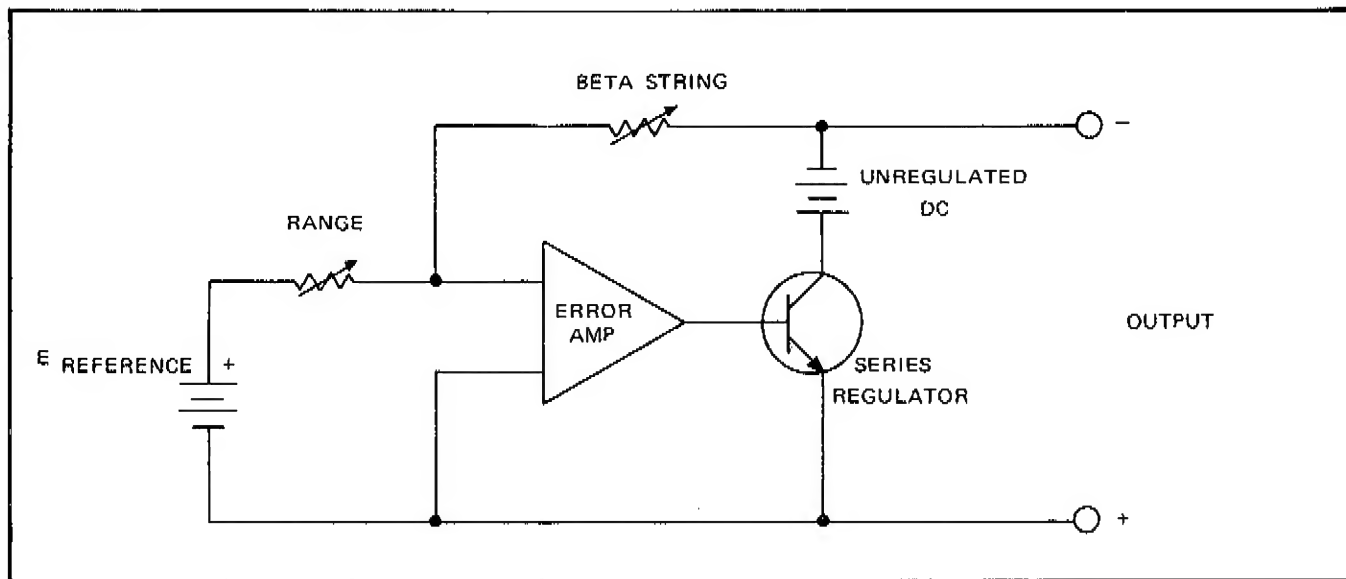


Figure 3-2. BASIC INSTRUMENT CIRCUITRY

Amplifier output is controlled by the range and beta string resistors, which control the input signal and the negative feedback.

3-5. The signal source is the +15 volt reference supply. A reference amplifier within the supply assures high stability with respect to time and temperature. An output current of 10 microamps, 100 microamps, or 1 milliamp for the 10 volt, 100 volts, and 1000 volt ranges respectively is selected by the range control switch. The resulting voltage at the summing junction S is applied to the input of the chopper-stabilized amplifier. The function of this amplifier is to control conduction of the series regulator so that the resulting voltage at S approaches zero. As shown on the signal flow line, signal current from the series regulator passes through the rectifier and filter and through the voltage control network into the summing junction, thereby completing the servo loop.

3-6. The chopper-stabilized amplifier consists of a chopper amplifier and a preamplifier. The chopper amplifier amplifies all frequencies from dc to approximately 30 Hz; the preamplifier is used principally for frequencies from 30 to approximately 500 kHz.

3-7. The controlled current limiter together with the chopper-stabilized amplifier and series regulator comprise a second servo loop, which operates under abnormal loading conditions, such as short circuited output, to ensure linear operation of the amplifier. The controlled current limiter continuously monitors output current and compares it to the setting of the current limit control. When the voltage across current sensing resistor R70 exceeds the refer-

ence voltage set by the current limit control, the limiter generates a current, which subtracts from the +15 volt reference current. Thus, the output is limited or clamped to the preset value.

3-8. The function of the negative voltage limiter is to ensure linear operation of the shopper-stabilized amplifier during periods, such as downranging, when the series regulator is cut off and the main servo loop is opened. The negative voltage limiter is activated, when the amplifier output attempts to go below -2.5 volts. The limiter then generates a current into the summing junction, which balances the input reference and beta string currents, thereby limiting the negative output of the amplifier. The action of the limiter thus assures fast recovery and settling time for the amplifier.

3-9. The primary function of the sink supply and crowbar circuitry is to quickly discharge the output capacitor and the high voltage filter capacitors when downranging the instrument. These circuits also provide protection for the instrument during abnormal load conditions, such as short circuited output. The sink supply serves two purposes: It discharges the output capacitor, and it protects the series regulator transistors by temporarily clamping the voltage across them to a safe value. The crowbar circuit protects the series regulator transistors by discharging the high voltage filter capacitors. It also generates a signal for the control circuit, which, under certain conditions, is used to trip the instrument to standby.

3-10. The control circuit provides a fixed delay of 3 to 5 seconds, following initial turn-on, before ac is connected

to the high voltage power supply. This allows the auxiliary power supplies time to stabilize and reach equilibrium before high voltage is applied. Secondly, the control circuit acts to trip the instrument to **STANDBY** when the output terminals are shorted at voltage settings of 300 or above on the 1000 volt range. The control circuit consists of an AND gate, which maintains the high voltage relay in an energized condition as long as both the delay and trip inputs are present.

3-11. The high voltage power supply is a conventional full-wave voltage doubler. Output voltage is determined by the range switch and most significant decade control switch, which select one of six voltage taps at the power transformer secondary.

3-12. CIRCUIT ANALYSIS

3-13. +15 VOLT REFERENCE AND AUXILIARY SUPPLIES

3-14. The +15 volt reference supply is a conventional series regulated power supply, employing a reference amplifier and an error amplifier to provide a stable, well regulated output. Filtered, unregulated dc voltage for the +15 volt supply is provided by CR22, CR25, and C23. Darlington amplifier Q15, Q23 together with zener diodes CR19 and CR20 form a simple preregulator. The preregulator improves line regulation and reduces noise due to power line transients. Reference amplifier Q14 is a single device containing matched zener reference and amplifier elements, thereby providing a voltage reference that is extremely stable with respect to temperature variations. Output voltage variations are sensed at the input of differential amplifier Q15, Q17. The amplified output of the differential amplifier is applied to the input of the Darlington amplifier pair Q20, Q19, which varies the conduction of Q19 to maintain a constant output voltage. Frequency response for the overall servo loop is controlled by R14 and C20.

3-15. Filtered dc voltage for the -15 volt auxiliary supply is provided by CR23, CR24, and C22. The voltage reference for this supply is the +15 volt reference supply output. The error amplifier consists of differential amplifier Q16, Q18. Series control of the output is provided by Darlington amplifier Q22, Q21. Transistor Q24 and associated components comprise a constant current source for Q16, thus achieving a high overall loop gain. Capacitor C21 and resistor R6 control the frequency for this servo loop.

3-16. CHOPPER-STABILIZED AMPLIFIER

3-17. The chopper amplifier consists of an input modulator, a high gain amplifier, a synchronous demodulator, and an output filter network. Input signals are restricted to less than 30 Hz by a low-pass filter consisting of R172, R171, and C47. The resulting baseband signal, dc to 30 Hz, is applied through R170 to the drain of MOS FET chopper Q39. Q39 is switched off and on at a 215 Hz rate by a squarewave signal applied to its gate, thus modulating the input signal and producing a squarewave output signal having an amplitude proportional to the amplitude of the baseband signal. The resulting signal is coupled to the input of JFET amplifier Q38. Use of the JFET as an input amplifier provides high input impedance and assures low noise operation. From Q39, the signal passes through IC1, an operational amplifier having a gain of approximately 420 and a frequency response of 20 Hz to 10 kHz. The output of IC1 is inverted in Q37 and appears with approximately equal amplitude at both collector and emitter of Q37. The collector signal is synchronously demodulated by shunt switch Q36. The resulting voltage is filtered by R129 and C31, leaving only the amplified dc and low frequency signals. The Q37 emitter signal is applied through a filter network to C31 to assist in reducing chopper ripple and to cancel any base band signal that is present. The purpose of CR57 is to assist in stabilization and quick recovery of the amplifier by providing a quick charge path for C36. Diode CR56 clamps the voltage at the emitter of Q36 to a safe value.

3-18. The source of the 215 Hz chopper drive signal is multivibrator Q2, Q3 and driver Q1. The signal at the collector of Q1 is coupled to the drain of Q39 to compensate for the dc error introduced by the gate-to-drain capacitance of Q39 and is adjusted by R162.

3-19. The preamplifier consists of two differential amplifiers and an output emitter follower. The signal passes through the input FET amplifier Q35, through a second differential pair Q33, Q34, and out the emitter of Q32 to the series regulator. The purpose of C1 and C2 on the reference board assembly is to reduce noise, principally 60 Hz ripple, by increasing the ac feedback at the undesired frequency.

3-20. SERIES REGULATOR

3-21. The series regulator is composed of a preregulator, a control transistor, and a fixed current limiter. The preregulator consists of four Darlington amplifiers in series Q42 through Q49. Resistors R58, R60, R61, and R64 divide the high voltage equally among the four amplifiers

so that each preregulator control transistor feels one-fourth of the high voltage. The base of the final preregulator control transistor Q42 is held at 12.4 volts by zener diode CR48. Consequently, the emitter of Q42 will be constant at approximately 11.6 volts, and the main control transistor Q40 will see no more than 11.6 volts for any value of high voltage output. The control transistor Q40 together with Q41 form a Darlington pair. The purpose of diode CR65 is twofold: It prevents breakdown of Q42 when Q40 is suddenly cut off, and it clamps the voltage at the collector of Q40 to a safe value. Diodes CR41 through CR45 prevent excessive voltage drops across current sensing resistor R70, which could occur under certain output load conditions, such as short circuited output.

3-22. Fixed current limiting is provided by Q50 and associated components and is designed to protect the series regulator against catastrophic failure. Q50 is connected as a shunt regulator across the base of Q41 and limits control transistor current to a maximum of 60 ma. When the current through R70 exceeds 60 ma, transistor Q50 conducts, drawing current away from the base of Q41, thereby limiting output current to 60 ma. The purpose of diode CR50 is to permit the preamplifier output voltage to swing below zero volts.

3-23. CONTROLLED CURRENT LIMITER

3-24. The controlled current limiter utilizes a differential amplifier Q11, Q12, a voltage amplifier Q10, and a diode-connected transistor Q8 to accomplish the current limit function. The voltage developed across current sensing resistor R70 is applied to the base of Q12. The base of Q11, which is the other input to the differential amplifier, is connected to the current control potentiometer R41. When the voltage developed across R70 exceeds the voltage set by R41, transistor Q12 ceases conduction. When Q12 stops conducting, a shunt current path is offered to the reference current flowing into the summing junction. This path is through Q8 and Q10 and into the -15 volt supply. The main amplifier input current is reduced accordingly, and the instrument output current is thus limited to the preset value. Resistor R44 and transistor Q8 form a coupling network, which prevents the leakage current of Q10 from affecting the summing junction current. Transistor Q8 is used as a diode because of its inherently low leakage.

3-25. Transistor Q13 is used to activate the controlled current limiter during instrument warmup and STANDBY conditions. The base of Q13 is connected to CR48, and cutoff bias is applied to Q13 as long as the voltage across

CR48 exceeds 8 volts. When the voltage across CR48 drops below 8 volts, Q13 conducts, cutoff bias is applied to Q12, and the current limiter is activated. The purpose of Q13 is covered in the control circuit discussion, paragraph 3-36.

3-26. The current limit lamp driver turns on the current limit light whenever the controlled current limiter is activated. When the current through Q12 is reduced at the beginning of the current limit operation, the current in Q11 increases. The current change in Q11 is amplified by Q9, which turns on switch Q7, lighting the current limit lamp DSI.

3-27. NEGATIVE VOLTAGE LIMITER

3-28. The negative voltage limiter consists of a two-stage inverting amplifier Q5, Q6, and a coupling diode Q4. The limiter is connected between the output and input of the chopper-stabilized amplifier. When the output of the chopper-stabilized amplifier attempts to go more negative than approximately -2.5 volts, transistor Q6 conducts hard enough to turn on Q5; and current flows from the +15 volt supply through Q5, through the coupling diode Q4, and into the summing junction at the input to the amplifier. This limiting current balances the input reference and beta string currents, thereby limiting the output of the amplifier to approximately -2.5 volts. Coupling diode Q4 and resistor R52 are used to limit the effects of leakage current in Q5. Resistor R51 and capacitor C14 control the frequency response of this servo loop. Again, transistor Q4 is used as a diode, because of its inherently low leakage.

3-29. SINK SUPPLY AND CROWBAR

3-30. The 730 volt sink supply is composed of two power supplies connected in series. The 570 volt supply is a full-wave voltage doubler consisting of diodes CR1, CR2, CR4, CR5 and capacitors C1 and C2. The 160 volt supply is a half-wave rectifier consisting of diode CR3 and capacitor C3. The load resistors for the sink supply are R96 and R97. The sink supply is connected through R96 and R97 across output capacitor C49. When the instrument is downranged, current flows through the sink supply and its load resistors to quickly discharge C49 to the selected downrange voltage.

3-31. When the instrument is downranged or the output is short circuited, the voltage across the series regulator will attempt to rise, because of the charge on the high voltage filter capacitors. The charge on these capacitors can be as high as 1500 volts. The sink supply clamps the voltage across the series regulator to a safe value until the crowbar

circuit is activated, which occurs in less than 100 milliseconds. The sink supply is connected across the series regulator, through diodes CR32 and CR33. When the voltage across the series regulator approaches 730 volts, CR32 and CR33 conduct, and the sink supply clamps the voltage across the regulator to 730 volts. As soon as the crowbar circuit is activated, the crowbar discharges the high voltage filter capacitors and the clamping function of the sink supply ceases.

3-32. The crowbar circuit consists of Schmitt trigger Q28, Q29, relay driver Q30, series regulator Q31, crowbar relays K2A and K3A and associated components. Under normal conditions, Q28 is cutoff and Q29 is conducting. Thus, Q30 is also off and the crowbar relays are de-energized. Assume the instrument is downranged. The output capacitor C49 begins to discharge and the voltage across the series regulator begins to rise. As this voltage rises, current flow increases through CR51, CR52, R88, and R89, thereby increasing the positive voltage at the base of Q28. When the voltage across the series regulator rises to within 40 volts of the sink supply voltage, Q28 is biased on and the Schmitt trigger changes state. This turns on the relay driver Q30, which activates the crowbar relays. The crowbar relays place R81 and R84 directly across filter capacitors C55 through C58, and the capacitors quickly begin to discharge. When the voltage across the filter capacitors has decreased by approximately 80 volts, the decreased voltage at the base of Q28 resets the Schmitt trigger, and the crowbar relays deenergize. The continued discharge of C49, however, causes the voltage across the series regulator to rise again. When the voltage rises to within 40 volts of the sink supply voltage, the crowbar circuit is again activated, and the filter capacitors are discharged another 80 volt step. This action continues until C49 and C55 through C58 have stabilized at the selected downrange voltage. The step discharge of the filter capacitors is a function of the hysteresis exhibited by the Schmitt trigger, that is, the Schmitt trigger is activated by a much higher voltage than is required to deactivate it. Thus, the crowbar relays are energized for a finite time period, which contributes greatly to minimum arcing at the contacts and, consequently, long contact life. Transistor Q31 is a series regulator for the Schmitt trigger and relay driver stages.

3-33. A second function of the crowbar circuit is to provide a trip signal to the control circuit whenever crowbar relay closure time becomes excessive. This will occur if the instrument output is short-circuited at voltage settings above 300 on the 1000 volt range. It will also occur if the instrument is downranged excessively. Closure of the crowbar relays applies a voltage to the RC time constant circuit

consisting of R101, R102, and C5, which determines the crowbar relay closure limits. When crowbar operation exceeds this limit, a positive trip voltage is coupled through CR67 to the control circuit.

3-34. CONTROL CIRCUIT

3-35. The control circuit consists of AND gate Q26, Q27, high voltage relay K1C, silicon controlled rectifier CR29, and associated components. When the instrument FUNCTION switch is set from OFF to STANDBY/RESET, voltage is applied to the control circuit, to the +15 volt reference supply, and to the auxiliary power supplies. At this time, the high voltage is disabled by contacts K1A of the high voltage relay; and the instrument output terminals are shorted by contacts K1B of the high voltage relay, which prevents any uncontrolled voltage from appearing on the output terminals while the amplifiers are stabilizing. Rectified voltage for the control circuit is provided by CR26, CR27, and CR24. This voltage is applied to the base of Q51 through a time constant circuit consisting of R86 and C25, thus delaying turn-on of Q51 for 3 to 5 seconds. This delay ensures that the auxiliary power supplies will be on and stabilized before high voltage is applied. The delayed voltage then turns on Q51 and Q27. The other input to the AND gate is controlled by the FUNCTION switch and is not present until the FUNCTION switch is set to ON. A positive voltage is then applied through R87 to the base of Q26, turning it on. The high voltage relay then operates, high voltage is applied to the main rectifier and filter, and normal operation ensues. The purpose of diode CR68 is to discharge C25 quickly in the event of power failure or other interruption of main power, thus assuring a full 3 to 5 second delay cycle.

3-36. In the STANDBY/RESET condition, the series regulator is cut off to ensure that the main control amplifier is within its linear operating range when the high voltage is applied. This is accomplished by Q13, which activates the controlled current limiter as described in paragraph 3-25. When the high voltage is off, there is no zener current for CR48. Consequently, transistor Q13 will be on and the controlled current limiter will be activated. The main feedback loop at this time is provided by the negative limiter, which clamps the output of the differential amplifier to -2.5 volts.

3-37. The trip function of the control circuit is accomplished by silicon controlled rectifier CR29. CR29 receives an enabling trigger under two conditions. When the crowbar relay closure is excessively long, a trigger voltage is developed as described in paragraph 3-33. A second means of triggering CR29 is provided by the circuit consisting of

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neon lamps DS1 and DS2 and resistor R98. This circuit is activated if the instrument output voltage becomes excessively high on the 10 or 100 volt ranges, for example, if the main amplifier opened and the series regulator were driven fully on. Under these conditions, DS1 and DS2 would fire and a positive trigger voltage would be developed at the anode of CR67. When the voltage at the gate of CR29 is sufficiently high, CR29 conducts and removes one input to the AND gate. This de-energizes the high voltage relay and places the instrument in STANDBY. To reset the relay, it is necessary to momentarily set the FUNCTION switch to STANDBY/RESET and back to ON.

3-38. HIGH VOLTAGE POWER SUPPLY

3-39. Diodes CR53 and CR54 and capacitors C55 through C58 comprise a full-wave voltage doubler. The voltage supplied to the doubler depends on the setting of the range switch and the most significant decade switch. On the 10 and 100 volt ranges, the high voltage output is fixed at about 500 volts. On the 1000 volt range, the eleven position decade switch selects a voltage ranging from 500 to 1500 volts.

3-40. METER CIRCUIT

3-41. The meter circuit is connected between + and - SENSE for voltage readings and is connected in shunt with R70 for output current readings. In current measurement mode, the meter current includes beta string current. This introduces a small error, which is negligible on the 10 and 100 volt ranges. On the 1000 volt range, the error will be equal to +1 milliamp.

3-42. BETA STRING

3-43. The beta string is a six-decade resistive network (seven decades on the 343A), which provides precise control of feedback to the chopper-stabilized amplifier, thereby controlling instrument output. The first decade of the 341A and the first and second decades of the 343A incorporate linearity adjustments, which are adjusted during calibration to ensure exact resistance ratios. The resistors and switches which comprise the beta string are located on reference board and sample string assemblies.

SECTION IV

MAINTENANCE

4-1. INTRODUCTION

4-2. This section contains information concerning preventive and remedial maintenance for the Model 341A/343A Voltage Calibrators. Preventive maintenance consists primarily of cleaning the instrument, which is performed periodically to sustain the instrument in peak operating condition. Remedial maintenance consists of troubleshooting, calibration, and performance test procedures, which are designed to aid in maintaining instrument operation within specifications. Section III of the instruction manual is an important supplement to the troubleshooting section, since a thorough knowledge of instrument theory is indispensable in troubleshooting.

4-3. SERVICE INFORMATION

4-4. Each instrument manufactured by the John Fluke Manufacturing Company is warranted for a period of one year upon delivery to the original purchaser. Complete warranty information is contained in the Warranty page located at the rear of this manual.

4-5. Factory authorized calibration and repair service for all Fluke Instruments is available at various world wide locations. A complete list of factory authorized service centers is located at the rear of the manual. If requested, an estimate will be provided to the customer before any repair work is begun on instruments which are beyond the warranty period.

4-6. TEST EQUIPMENT

4-7. Figure 4-1 lists the equipment recommended for performance testing, troubleshooting, and calibration. If the recommended equipment is not available, other equipment which meets the required specifications may be used.

4-8. GENERAL MAINTENANCE

4-9. MAINTENANCE ACCESS

4-10. Main circuit board components are accessible from the top of the instrument after removing the top cover, which is held in place with six Dzus fasteners.

4-11. The reference board and sample string assemblies are located in the compartment just forward of the main circuit board. The compartment covers are each held in place with two machine screws. To replace components on the reference board assembly, sample string assembly, or front panel assembly, proceed as follows:

- a. Remove top and bottom instrument covers.
- b. Remove the reference and sample string assembly compartment covers.
- c. Remove the narrow front covers just above and below the meter.
- d. Remove the front panel and first bulkhead assemblies as a unit by removing the eight screws which hold the assemblies to the side rails, disconnecting the leads to pin 1 and 6 of the sample string assembly, and sliding the assemblies carefully forward, away from the main unit, as far as the wiring harness will permit.

NOTE

The shafts of the RANGE and first decade switches will disengage from the switch rotors as the front panel is removed. To ensure proper shaft orientation when replacing the front panel, be sure to note the switch positions before disassembly.

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| EQUIPMENT NOMENCLATURE | SPECIFICATIONS REQUIRED | RECOMMENDED EQUIPMENT |
|---|--|--|
| DC Differential Voltmeter | Range: 0 to +1100 vdc Accuracy: $\pm 0.0025\%$ of input | Fluke Model 895A |
| Oscilloscope | Sensitivity: 20 mv/cm Sweep: 1 msec/cm | Tektronix Model 541 |
| True RMS Voltmeter | Range: 10 to 100 mv Accuracy: 0.05% | Fluke Model 931B |
| Preamplifier | Gain: 1000 Bandpass: 5 Hz to 100 kHz | |
| Autotransformer | Voltage: 0 to 130 vac Current: 3 amp | General Radio Model W5MT3AW |
| Wattmeter | 0 to 200w | |
| Multimeter | Accuracy: $\pm 2\%$ dc $\pm 3\%$ ac Input Impedance: 11 megohms dc 1 megohm ac | Fluke Model 853A |
| Load Resistors | 40 ohms, $\pm 5\%$, 1/2w 400 ohms, $\pm 5\%$, 1w 4k, $\pm 5\%$, 10w 40k, $\pm 5\%$, 50w | Clarostat Model 240C |
| | 400 ohms, $\pm 1\%$, 1w | |
| Null Detector (Model 343A only) | Sensitivity: 1 uv | Fluke Model 845AR or 845AB |
| Standard Cell (Model 343A only) | Accuracy: $\pm 0.0005\%$ | Guildline Instruments Model 9152/P4 |
| DC Voltage Calibration System (343A only) Reference Divider DC Voltage Source Null Detector | Range: 0.1 to 1100 vdc Accuracy: 10 ppm | Fluke Model 7100B, consisting of the following equipment: Fluke Model 750A Fluke Model 332B Fluke Model 845AR |

Figure 4-1. TEST AND CALIBRATION EQUIPMENT

- e. Remove the nine screws which hold the sample string assembly in place on the rear of the first bulkhead. The reference board assembly is held in place on the front of the second bulkhead by six screws.
- f. Separate the front panel from the first bulkhead by removing the RANGE, FUNCTION, CURRENT LIMIT, and voltage control knobs and unsoldering the wires which connect to the output terminals.
- c. Remove the eight screws which hold the rear panel to the side rails.
- d. Remove the four transformer screws, which are located on the rear panel.
- e. Remove the two screws which hold the rear panel to the center bulkhead.
- f. Separate the rear panel from the main unit to the extent permitted by the wiring.

4-12. To gain access to rear-panel-mounted components, proceed as follows:

- a. Remove the top and bottom covers.
- b. Remove the narrow covers located immediately above and below the rear panel.

4-13. ADJUSTMENT LOCATIONS

4-14. All controls required for calibration and troubleshooting are accessible from the top of the instrument after removing the top cover. See Figure 4-2 for Model 341A adjustment locations and Figure 4-3 for Model 343A adjustment locations.

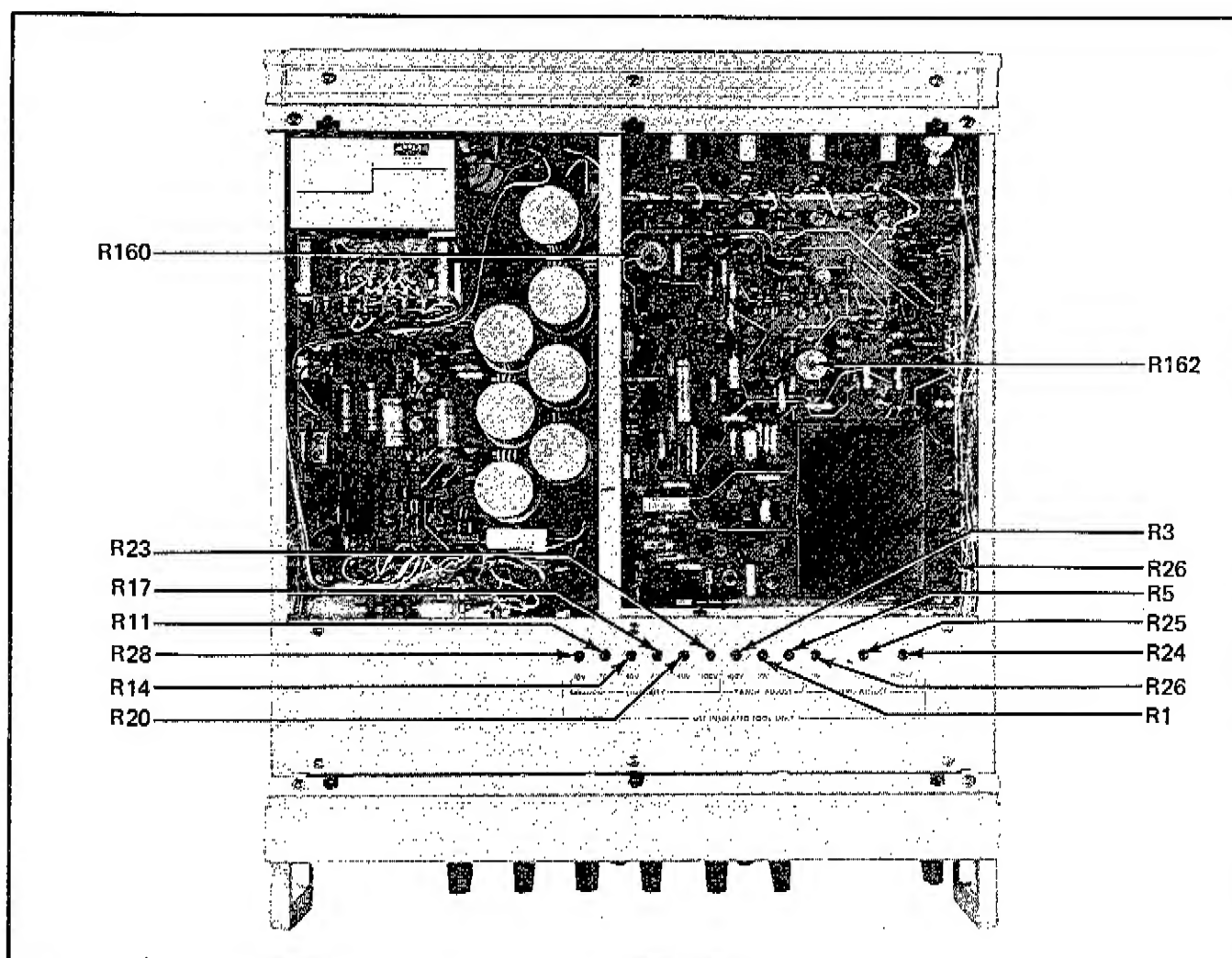


Figure 4-2. MODEL 341A ADJUSTMENT LOCATIONS

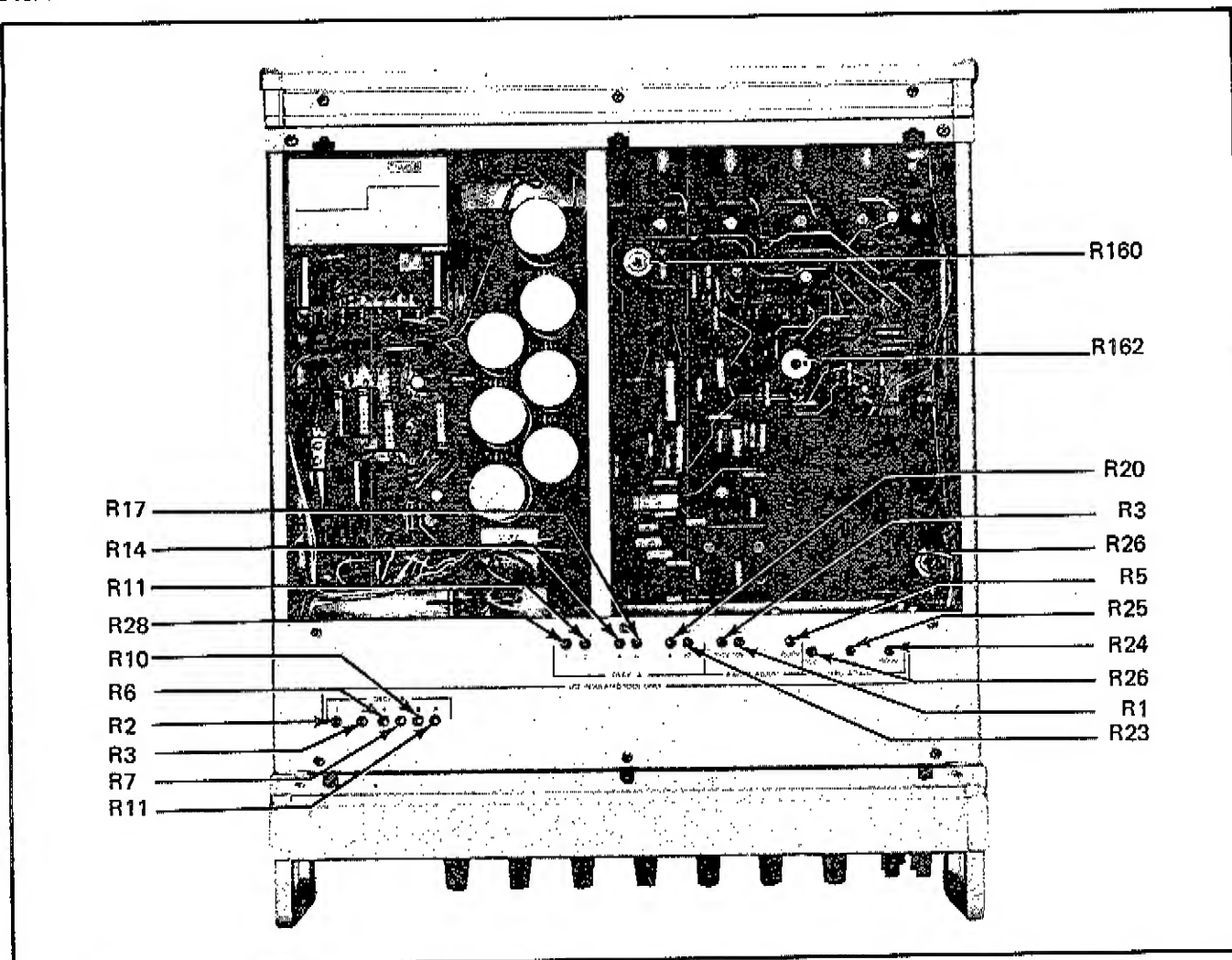


Figure 4-3. MODEL 343A ADJUSTMENT LOCATIONS

4-15. CLEANING

4-16. The instrument should be cleaned periodically to remove dust, grease, and other contamination. Since the instrument is completely enclosed, having no fans, the need for cleaning is reduced. Care has been taken to prevent leakage, through the use of high quality insulating materials in all switches and through special attention to component layout. In addition, all circuit boards are coated with a moisture sealant.

4-17. To clean the instrument, proceed as follows:

CAUTION!

Avoid touching the polyethylene grommets; contamination can cause excessive electrical leakage.

- a. Remove loose contamination from the instrument with low-pressure, clean, dry air. Pay particular attention to the front panel binding posts, binding post wiring, switches, and polyethylene grommets.
- b. Clean the polyethylene binding posts and the front panel with anhydrous ethyl alcohol or an aerosol can of Freon TF Degreaser (Miller-Stephenson Chemical Co., Inc.). When necessary, clean the exposed dielectric surfaces of switches with anhydrous alcohol, using a small, stiff-bristled brush which has been wrapped with a clean cloth to prevent saturating the switch contacts. After cleaning, recoat the exposed dielectric surfaces with silicon fluid. This will prevent leakage along these surfaces due to moisture.

CAUTION!

Do not use Metriclene, acetone, lacquer thinner, Freon TF Degreaser, or any ketone on the

Lexan switch shafts and spacers, because they will react with the Lexan. Also, do not saturate the switch contacts, which have been permanently lubricated.

- c. Printed circuit boards have been coated with epocast (a polyurethane resin) to inhibit fungus growth and moisture absorption. When soldering to a printed circuit land, the heat from the soldering iron decomposes the epocast resin, leaving a charred residue. Upon completion of soldering, this residue should be removed with a solvent, such as toluol.

CAUTION!

The following precautions should be adhered to when using toluol: Avoid inhaling the vapors, avoid excessive contact with the skin, and keep away from open flames. Ensure that plastic components do not come into contact with toluol, since it will dissolve most types of plastic.

- d. After removal of the epocast residue, the affected area should be recoated with a sealant. A spray can of Circuit Coat (Furane Plastic Inc., 4516 Brazil Street, Los Angeles, California or 16 Spielman Road, Fairfield, New Jersey) may be used for recoating.

4-18. 115/230 VOLT CONVERSION

4-19. The Model 341A/343A may be operated from either a 115 or 230 volt ac power line, depending upon the connection of the power transformer primary winding. Convert the instrument from one type of power line operation to the other by the following procedure:

- Disconnect the instrument from the power line.
- Remove the top cover. The power transformer is located in the rear of the instrument, near the point of line cord entry.
- Orient the instrument and perform the appropriate electrical connections as shown in Figure 4-4.
- Use the proper fuse for the selected voltage, as specified in paragraph 4-20.

4-20. FUSE REPLACEMENT

4-21. Instrument fuses are contained in bayonet type fuse holders located at the rear of the instrument. Correct values for the fuses are as follows:

| REFERENCE DESIGNATION | FUNCTION | RATING |
|--------------------------|----------------------|--|
| F1 | Line fuse | 115 volt connections 1 amp, slow-blow |
| | | 230 volt connections 1/2 amp, slow-blow |
| F2 | High voltage fuse | 1/16 amp, slow-blow |

4-22. LAMP REPLACEMENT

4-23. RANGE, LIMIT ON, and power ON lamps are located immediately behind the front panel. They are accessible from the top of the instrument after removing the top instrument cover and the narrow front cover just

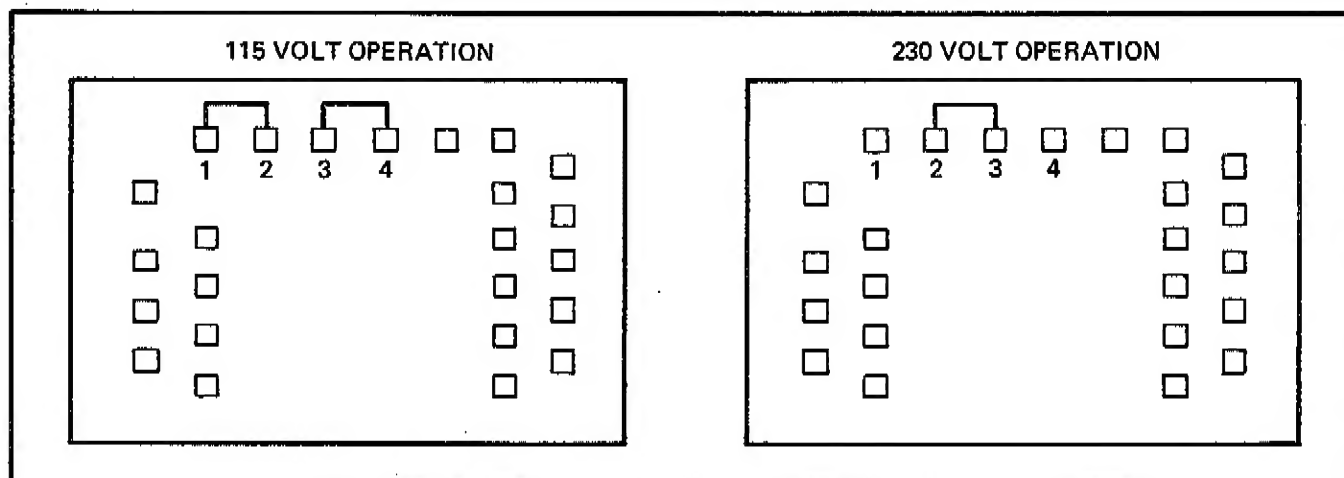


Figure 4-4. 115/230 VOLT CONVERSION

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above the meter. The lamps are easily removeable without special tools. The two control circuit lamps, DS1 and DS2 are located on the main circuit board and are accessible after removing the top cover.

4-24. PERFORMANCE TESTS

4-25. Performance tests consist of line regulation, load regulation, ripple, and output voltage accuracy tests, and are designed to compare instrument performance to specifications. The tests may be used during maintenance or for receiving inspection. Test should be performed under standard test conditions: ambient temperature $23 \pm 1^{\circ}\text{C}$, relative humidity less than 70%. Allow instrument to warm up for at least 1 hour before testing. An instrument that fails any of the performance tests may require corrective maintenance or calibration. In case of trouble, analysis of the tests results, with reference to the troubleshooting section, should help to locate the trouble.

NOTE!

Unless otherwise specified, the following tests apply to both Model 341A and Model 343A instruments.

4-26. LINE REGULATION

4-27. The line regulation test determines whether the output voltage of the instrument will remain constant, within specified limits, for low and high line voltages.

- Connect the autotransformer to the line, and connect the Model 341A to the autotransformer. Adjust the autotransformer for 115 volts output.
- Set the Model 341A/343A controls as follows:

| FUNCTION | STANDBY/RESET |
|---------------|---|
| RANGE | 10 |
| Voltage Dials | 1.00000 (Model 341A) 1.000000 (Model 343A) |
| CURRENT LIMIT | Fully clockwise |

- Connect a 40 ohm $\pm 5\%$, 1/2 watt resistor to the Model 341A/343A OUTPUT terminals.
- Connect the 895A differential voltmeter to the OUTPUT terminals, and set the FUNCTION switch to ON.

- Vary the line voltage from 115 volts to 103.5 volts. The 895A should indicate a voltage change of less than 30 microvolts.
- Vary the line voltage from 115 volts to 126.5 volts. The 895A should indicate a voltage change of less than 30 microvolts.
- Repeat steps c through f with loads and instrument settings as follows. The maximum voltage changes should be as indicated.

| LOAD | RANGE | VOLTAGE DIALS | MAXIMUM VOLTAGE CHANGE |
|---------------------------|-------|-------------------------------------|------------------------|
| 400 ohms $\pm 5\%$ 1 w | 10 | 10.00000 (341A) 10.000000 (343A) | 75 μv |
| 4k $\pm 5\%$ 10 w | 100 | 100.0000 (341A) 100.00000 (343A) | 525 μv |
| 40k $\pm 5\%$ 50 w | 1000 | 1000.000 (341A) 1000.0000 (343A) | 5 mV |

FAULT ANALYSIS

If the line regulation is not within limits, it is likely that the chopper amplifier or preamplifier gain is too low. Check chopper amplifier performance as described in paragraph 4-47. Check test point 8 (TP8) voltages in the preamplifier as described in paragraph 4-45.

4-28. LOAD REGULATION

4-29. The load regulation test determines if the instrument output voltage will remain constant, within specified limits, under no-load to full-load conditions.

- Connect the autotransformer to the line, and connect the Model 341A/343A to the autotransformer. Adjust the autotransformer for 115 volts output.
- Set the Model 341A/343A controls as follows:

| FUNCTION | STANDBY/RESET |
|---------------|---|
| RANGE | 10 |
| Voltage dials | 1.00000 (Model 341A) 1.000000 (Model 343A) |
| CURRENT LIMIT | Fully clockwise |

- c. Jumper the SENSE terminals to the output terminals.
- d. Connect the 895A differential voltmeter to the SENSE terminals, and set the FUNCTION switch to ON.
- e. Record the voltage indicated by the 895A.
- f. Connect a 40 ohm $\pm 5\%$, 1/2 watt resistor to the OUTPUT terminals. The voltmeter should indicate a voltage change of less than 30 microvolts.
- g. Remove the 40 ohm resistor, and set the voltage dials to 10.00000 (10.000000 for the Model 343A). Record the voltage indicated by the 895A.
- h. Connect a 400 ohm $\pm 5\%$, 1 watt resistor to the OUTPUT terminals. The 895A should indicate a voltage change of less than 75 microvolts.
- i. Remove the 400 ohm resistor. Set the RANGE switch to 100 and the voltage dials to 100.0000 (100.00000 on Model 343A). Record the voltage indicated by the 895A.
- j. Connect a 4k $\pm 5\%$, 10 watt resistor to the OUTPUT terminals. The 895A should indicate a voltage change of less than 525 microvolts.
- k. Remove the 4 k resistor. Set the RANGE switch to 1000 and the voltage dials to 1000.000 (1000.0000 on the Model 343A). Record the voltage indicated by the 895A.
- l. Connect a 40k $\pm 5\%$, 50 watt resistor to the OUTPUT terminals. The 895A should indicate a voltage change of less than 5 millivolts.
- m. Repeat steps a. through m. for line voltages of 103.5 volts ac and 126.5 volts ac.

FAULT ANALYSIS

If load regulation is poor, check for proper operation of the preamplifier and chopper amplifier as described in paragraph 4-45 and 4-47. Also, ensure that SENSE terminals are connected properly. See paragraph 2-14.

4-30. RIPPLE

4-31. The ripple test determines if the ac ripple present on the instrument dc output is within specified limits.

- a. Install top and bottom instrument covers, and connect + OUTPUT to chassis ground.
- b. Connect the preamplifier to the OUTPUT terminals, and connect the 931B true rms voltmeter to the output of the preamplifier.
- c. Set the FUNCTION switch to on, and set the RANGE switch and voltage dials as shown in Figure 4-5. The rms ripple should not exceed the values shown.

| RANGE | VOLTAGE DIALS | MAXIMUM RIPPLE | | | | | |
|-------|---|-----------------------|------|-------|--------|---------------------|------|
| | | 115 VAC 50-60 HZ LINE | | | | 115 VAC 400 HZ LINE | |
| | | 341A | | 343A | | 341A / 343A | |
| | | RMS | P-P | RMS | P-P | RMS | P-P |
| 10 | <u>10.00000</u> (341A) <u>10.000000</u> (343A) | 100 uv | 1 mv | 50 uv | 400 uv | 100 uv | 2 mv |
| 100 | <u>100.0000</u> (341A) <u>100.00000</u> (343A) | 100 uv | 1 mv | 50 uv | 400 uv | 100 uv | 2 mv |
| 1000 | <u>1000.000</u> (341A) <u>1000.0000</u> (343A) | 100 uv | 1 mv | 50 uv | 400 uv | 100 uv | 2 mv |

Figure 4-5. RIPPLE SPECIFICATIONS

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- d. Remove the 931B from the output of the preamplifier and connect the oscilloscope in its place.
- e. Repeat step c. The p-p ripple should not exceed the values shown.

FAULT ANALYSIS

If ripple is excessive, check for ground loops in equipment connections and check for proper operation of the preamplifier and chopper amplifier, paragraphs 4-45 and 4-47.

4-32. OUTPUT VOLTAGE ACCURACY

4-33. If the instrument has successfully passed the line, load, and ripple tests, it can be assumed to be operating correctly. The output voltage accuracy test compares the instrument output voltage to the accuracy specifications given in Section I.

4-34. Model 341A Output Voltage Test.

- a. Connect the 895A to the Model 341A OUTPUT terminals, with the negative OUTPUT terminal connected to chassis ground.
- b. Set the Model 341A controls as shown in Figure 4-11. The output voltages should be as indicated in column 2.

FAULT ANALYSIS

If output voltages are incorrect, check the +15 volt reference adjustment, paragraph 4-64; the zero output adjustments, paragraph 4-65; the range adjustments, paragraph 4-67; and the beta string, paragraph 4-57.

4-35. Model 343A Output Voltage Test. To check the Model 343A output voltage accuracy, perform the Model 343A calibration verification procedure, paragraph 4-84, steps a through h. The output voltages should be as indicated in Figure 4-17, column 2.

FAULT ANALYSIS

If output voltages are incorrect, check the +15 volt reference adjustment, paragraph 4-73; the zero output adjustments, paragraphs 4-74 and 4-79; the range adjustments, paragraph 4-82; and the beta string, paragraph 4-57.

4-36. TROUBLESHOOTING

4-37. In the following checks, paragraphs 4-39 through 4-59, the performance of the major functional circuitry is examined by an appropriate test. These tests together with specific troubleshooting, information are intended to aid in locating instrument malfunctions. The tests begin with power-off resistance checks, proceed to standby and power-on checks, and conclude with specific functional circuit checks. The tests should be performed in the order given, unless the general trouble location is suspected beforehand.

4-38. When measuring voltages on the circuit boards, it is recommended that the major portion of the voltage probe be wrapped with insulating tape. This will reduce the possibility of damaging a transistor due to an accidental short circuit. For component locations, refer to the illustrated parts breakdown in Section V.

WARNING!

Voltages hazardous to life will be present. Use extreme caution. When troubleshooting, it is recommended that the + OUTPUT terminal be jumpered to the chassis ground terminal to reduce shock hazard.

4-39. TEST POINT RESISTANCE CHECK

4-40. This test consists of a resistance check of all power supply outputs within the instrument.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | OFF |
| RANGE | 10 |
| Voltage Dials | 10.00000 (Model 341A) 10.000000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Connect 853A common to + SENSE. Measure the resistance between the following points and the + SENSE terminal. Resistance should be as indicated.

| TEST POINT | APPROXIMATE RESISTANCE IN OHMS |
|------------|-----------------------------------|
| TP2 | 2500 |
| TP3 | 3700 |
| TP5 | >100k |
| TP6 | 340 |
| TP7 | >100k |
| - SENSE | 58 |

FAULT ANALYSIS

If there are errors in test point resistance readings, check the following components.

| <u>TEST POINT</u> | <u>POSSIBLE TROUBLE</u> |
|-------------------|--|
| TP2 | Defective diode CR17 Defective transistor Q6 or Q11 |
| TP3 | Defective transistor Q9, Q11, or Q18 |
| TP5 | Defective diode CR1, CR2, CR3, CR4 or CR5 |
| TP6 | Defective diode CR26 or CR27 Defective lamp DS5, DS6 or DS7 |
| TP7 | Defective capacitor C54 Shorted relay K2A and K3A |
| - SENSE | Resistor R169 changed value |

4-41. STANDBY TEST

4-42. This test determines instrument power consumption and verifies proper operation of the controlled current limiter under standby conditions.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | OFF |
| RANGE | 10 |
| Voltage dials | 10.00000 (Model 341A) 10.000000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Connect the instrument through the wattmeter to a 115 volt $\pm 1\%$, 60 Hz source.
- c. Set FUNCTION switch to STANDBY/RESET. The wattmeter should indicate approximately 10 watts and the LIMIT ON lamp should illuminate.

FAULT ANALYSIS

(1) If the LIMIT ON lamp does not light in STANDBY, check the following: lamp DS3 for continuity, test point 2 (TP2) and TP3 for proper +15 and -15 volt outputs, Q13 for proper operation, and controlled current limiter for proper operation.

4-43. AUXILIARY SUPPLY VOLTAGES

4-44. In the following test, the auxiliary supplies are tested by measuring their respective output voltages.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | STANDBY/RESET |
| RANGE | 10 |
| Voltage Dials | 10.00000 (Model 341A) 10.000000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Connect the 895A common to the + SENSE terminal, and measure the following test point voltages. Voltages should be as indicated.

| <u>TEST POINT</u> | <u>DC VOLTS</u> |
|-------------------|------------------|
| TP1 | 21 to 24 |
| TP2 | 14.999 to 15.001 |
| TP3 | -14.5 to -15.5 |
| TP4 | 540 to 600 |
| TP5 | 690 to 760 |

FAULT ANALYSIS

If the auxiliary supply voltages are not correct, check for possible defective components as follows:

| <u>TEST POINT</u> | <u>POSSIBLE TROUBLE</u> |
|-------------------|--|
| TP1 | Defective diode CR19, CR20 Defective transistor Q23 or Q24 |
| TP2 | Defective transistor Q19, Q20 or Q14 |
| TP3 | Defective +15 volt supply Defective transistor Q21 or Q22 Defective diode CR21 |
| TP4 | Defective diode CR1, CR2, CR4 or CR5 |
| TP5 | Defective diode CR3 |

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4-45. POWER-ON TEST

4-46. This test determines instrument power consumption under power-on conditions and verifies proper operation of the chopper-stabilized amplifier.

- a. Set Model 341A/343A control as follows:

| | |
|---------------|---|
| FUNCTION | OFF |
| RANGE | 10 |
| Voltage dials | <u>10.00000</u> (Model 341A) <u>10.000000</u> (Model 343A) |
| CURRENT LIMIT | Fully clockwise |

- b. Connect the instrument through the wattmeter to a 115 volt $\pm 1\%$, 60 Hz source.
- c. Set FUNCTION switch to STANDBY/RESET.
- d. Measure the voltage at TP8 with the 895A, using + SENSE as common. The voltmeter should indicate between -1.7 and -2.1 volts.
- e. Set FUNCTION switch to ON. The wattmeter should indicate approximately 15 watts and the LIMIT ON lamp should extinguish.
- f. Repeat step d. The 895A should indicate between +2.3 and +2.7 volts.
- g. Connect the 895A to the OUTPUT terminals. The 895A should indicate between 9.999 and 10.001 volts dc (9.9997 to 10.0003 volts dc for the Model 343A).

— FAULT ANALYSIS —

(1) If the ON lamp does not light in the FUNCTION-ON position, check for possible defective lamp DS4 and for proper operation of the control circuit.

(2) If the TP8 voltages are not within limits, the trouble is probably in the negative voltage limiter. It may also be due to preamplifier imbalance or improper chopper amplifier operation. Check the input voltage to the controlled current limiter; in STANDBY, it should be approximately zero volts. Check Q35 for balance; with C31 shorted, the drain voltages of Q35 should be equal within 0.5 volts. Check the chopper amplifier as described in paragraph 4-47.

(3) If the LIMIT ON lamp does not extinguish in FUNCTION-ON position, check the high voltage fuse F2, check for proper control circuit operation, and check controlled current limiter operation, paragraph 4-51.

(4) If the output voltage is not within limits, check as described in paragraph 4-34 (paragraph 4-35 for the Model 343A).

4-47. CHOPPER AMPLIFIER

4-48. This test verifies proper chopper amplifier operation by examining multivibrator and chopper amplifier signal characteristics.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage dials | <u>10.00000</u> (Model 341A) <u>10.000000</u> (Model 343A) |
| CURRENT LIMIT | Fully clockwise |

- b. Connect the oscilloscope 10:1 attenuator probe to test point TP9, using + SENSE as common.
- c. Set the oscilloscope input to dc, vertical sensitivity to 0.2 volts per centimeter, and sweep speed to 1 millisecond per centimeter.
- d. Compare the oscilloscope display with the waveform shown in Figure 4-6 for amplitude, period, and symmetry. The observed signal parameters should be equal to those of the given signal within $\pm 10\%$.

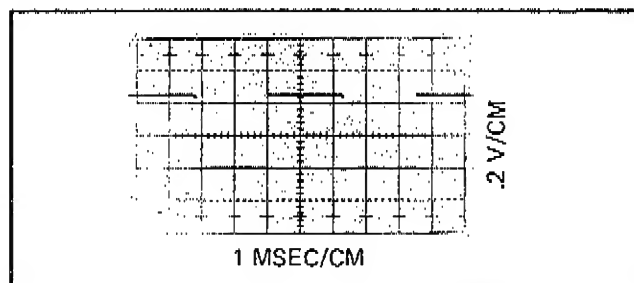


Figure 4-6. MULTIVIBRATOR SIGNAL -- TP9

- e. Connect the oscilloscope 10:1 attenuator probe to TP10, using + SENSE as common.

NOTE

Ensure that the bottom cover is in place on the instrument when observing the signal at TP10. The top cover should be slid back just far enough to admit the probe.

- f. Set the oscilloscope input to ac, vertical sensitivity to 0.02 volts per centimeter and sweep speed to 1 milli-second per centimeter.
- g. Compare display with the waveform shown in Figure 4-7, which indicates proper adjustment of spike compensation control R162. The signal is acceptable if the positive and negative spike amplitudes are less than 0.3 volts.

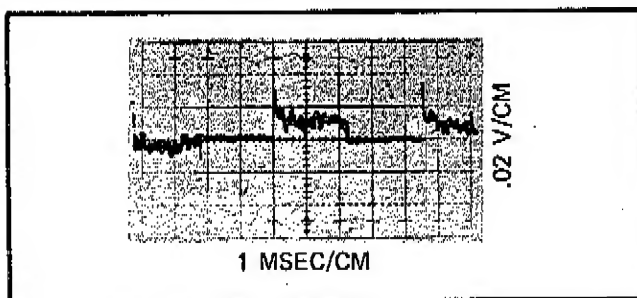


Figure 4-7. CHOPPER AMPLIFIER SIGNAL - TP10

- h. If the signal obtained in step g. is not acceptable, it will be necessary to adjust R160 and R162. Proceed as follows:
 - (1) Set chopper drive control R160 fully clockwise.
 - (2) Adjust R162 for minimum spike amplitude. A point should be found where the positive and negative spike amplitudes are approximately equal and nulled.
 - (3) Rotate chopper drive control R160 counter-clockwise until noise spikes begin to appear in the formerly quiet regions.
 - (4) Reverse the adjustment of R160 just far enough to restore the quiet region.
 - (5) Repeat step g.

NOTE!

Adjustment of R160 and R162 affects the output zero on the 10 volt range; therefore, it will

be necessary to perform the 10 volt zero and range adjustments, paragraphs 4-65 and 4-67 (paragraphs 4-74, 4-79, and 4-83 for the Model 343A).

FAULT ANALYSIS

- (1) If signal at TP9 is not correct, check for square wave signal at the collector of Q2. Transistor Q39, Q1, Q2 or Q3 may be defective.
- (2) If the signal at TP10 is not correct, integrated circuit IC1 or MOS FET transistor Q38 or Q39 may be defective.

4-49. SERIES REGULATOR

4-50. This test verifies proper operating voltages for the control transistor and preregulator transistors.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage dials | 10.00000 (Model 341A) 10.000000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Connect the 895A between the metal case (collector) of Q40 and the + OUTPUT terminal. The voltmeter should indicate between 10 and 13.5 volts dc.
- c. Connect a 400 ohm $\pm 5\%$, 1 watt resistor to the OUTPUT terminals and connect the positive OUTPUT terminal to chassis ground.
- d. Using the 853A multimeter, measure and record the collector-to-emitter voltages of each series regulator transistor, Q48, Q46, Q44, and Q42. The voltages should differ by less than 25 volts dc.

FAULT ANALYSIS

- (1) If the collector voltage of Q40 is not within limits, zener diode CR48 is probably defective. Also check transistors Q40, Q42 and Q43.
- (2) If the voltage division across the preregulator is not equal within 25 volts, check transistors Q42 through Q49 and check for a change in value of resistors R58, R60, R61, or R64.

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4-51. CONTROLLED CURRENT LIMITER

4-52. This test verifies proper limiter operation and determines the current control range.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage dials | 10.00000 (Model 341A) 10.000000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Connect the 853A, set to the 100 milliamp range, to the OUTPUT terminals. The LIMIT ON lamp should illuminate and the 853A should indicate between 25 and 36 milliamps.
- c. Set the CURRENT LIMIT control fully counter-clockwise. The range of adjustment should be approximately 30 milliamps.
- d. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | ON |
| RANGE | 1000 |
| Voltage dials | 100.0000 (Model 341A) 100.00000 (Model 343A) |

- e. Adjust the CURRENT LIMIT control through its range, while observing the 853A. The range of adjustment should be approximately 34 milliamps.

— FAULT ANALYSIS —

If controlled current range is not sufficient, check +15 and -15 volt supply output voltages and check transistors Q11 and Q12.

4-53. CROWBAR

4-54. In the following test, crowbar circuitry is exercised by short-circuiting the output and by down ranging the instrument excessively.

- a. Set Model 341A/343A controls as follows:

| | |
|---------------|---|
| FUNCTION | METER VOLTAGE |
| RANGE | 1000 |
| Voltage dials | 100.000 (Model 341A) 100.0000 (Model 343A) |

CURRENT LIMIT Fully clockwise

- b. Short circuit the OUTPUT terminals, and set the voltage dials to 300.000 (300.0000 on the Model 343A). The LIMIT ON lamp should illuminate, and the instrument should trip to STANDBY.
- c. Remove the short from the OUTPUT terminals and reset the instrument. The LIMIT ON lamp should extinguish, and the ON lamp should illuminate.
- d. Set the voltage dials to 1000.000 (1000.0000 on Model 343A), and then downrange the instrument by setting the RANGE switch to 100. The crowbar relays K2A and K3A should operate several times very rapidly, or rattle, as the RANGE switch is changed.
- e. Repeat step d several times, allowing at least 5 seconds between range changes.
- f. Repeat step e several times, allowing only 2 seconds or less between range changes. The instrument should trip to standby.

— FAULT ANALYSIS —

- (1) If instrument does not trip to STANDBY when the OUTPUT terminals are shorted at 300 volts output, check the Schmitt trigger input (voltage across R89). This voltage should be at least 6 volts to trigger the Schmitt circuit. If input is correct, check other Schmitt trigger components, especially transistor Q31, zener diode CR55, and relays K2B and K3B. Also, check diodes CR6, CR8, CR29, CR66 and CR67.
- (2) If the crowbar relays do not rattle when the instrument is downranged from 1000 volts, check for proper operation of the Schmitt trigger circuit.
- (3) If instrument does not trip to STANDBY when it is downranged repeatedly as described in step f, check for defective components in the gate circuit of CR29.

4-55. HIGH VOLTAGE POWER SUPPLY

4-56. This test verifies proper operations of the high voltage power supply by measuring rectifier output voltages for all instrument voltage ranges.

- Connect the 895A to TP7, using + OUTPUT as common.
- Set FUNCTION switch to ON and RANGE switch to 1000.
- Set the voltage dials as shown in Figure 4-8, and verify the voltages are as indicated.

| VOLTAGE DIALS | | TP7 VOLTS |
|---------------|-----------|------------|
| 341A | 343A | |
| 200.000 | 200.0000 | 300 to 360 |
| 500.000 | 500.0000 | 360 to 420 |
| 700.000 | 700.0000 | 410 to 480 |
| 800.000 | 800.0000 | 450 to 520 |
| 900.000 | 900.0000 | 450 to 520 |
| 1000.000 | 1000.0000 | 470 to 540 |

Figure 4-8. HIGH VOLTAGE POWER SUPPLY
OUTPUT VOLTAGES

FAULT ANALYSIS

If the high voltage power supply voltages are not correct, check diodes CR53 and CR54, capacitors C55 through C58, and transformer T1.

4-57. BETA STRING

4-58. The following sequence of tests is intended to detect gross errors in the beta string resistors or their switching patterns.

- Connect the 895A to the OUTPUT terminals. Set the 895A to TVM mode, with readout dials at zero.
- Set the Model 341A/343A controls as follows:

| | |
|---------------|-----------------|
| FUNCTION | ON |
| RANGE | 100 |
| Voltage dials | Zero |
| CURRENT LIMIT | Fully clockwise |
- Null the 895A on the 100 uV range.
- Set the Model 341A/343A and 895A controls as shown in Figure 4-9. The voltage increments should correspond to the values shown.

| VOLTAGE DIAL TESTED | | 895A | | OUTPUT VOLTAGE INCREMENT |
|---------------------|----------|-------|-------|--------------------------|
| 341A | 343A | RANGE | NULL | |
| 00.0000 | 00.00000 | 100 | TVM | 10v |
| 00.0000 | 00.00000 | 10 | TVM | 1v |
| 00.0000 | 00.00000 | 1 | TVM | 0.1v |
| 00.0000 | 00.00000 | 1 | .1 | 10 mv |
| 00.0000 | 00.00000 | 1 | .01 | 1.0 mv |
| 00.0000 | 00.00000 | 1 | 1 MV | 100 uv |
| | 00.00000 | 1 | 100uV | 10 uv |

Figure 4-9. BETA STRING SWITCHING
REQUIREMENTS

FAULT ANALYSIS

If the beta string switching is incorrect, it is likely that one or more beta string resistors, has changed value. Check for defective resistors, and perform the zero output adjustments and beta string calibration, paragraphs 4-65 and 4-66 (paragraphs 4-74, 4-75, 4-79, and 4-80 for the Model 343A).

4-59. PANEL METER

4-60. The following test verifies proper operation of the meter circuit by comparing full-scale meter readings to instrument output voltages.

- Set the FUNCTION switch to METER VOLTAGE.
- Set RANGE switch to 10 and voltage dials to 10.00000 (10.000000 on Model 343A). The instrument meter should indicate 10 volts $\pm 5\%$.
- Set RANGE switch to 100 and voltage dials to 100.0000 (100.00000 on Model 343A). The instrument meter should indicate 100 volts $\pm 5\%$.
- Set RANGE switch to 1000 and voltage dials to 1000.000 (1000.0000 on Model 343A). The instrument meter should indicate 1000 volts $\pm 5\%$.
- Set RANGE switch to 10 and voltage dials to 10.00000 (10.000000 on Model 343A).
- Set CURRENT LIMIT control maximum clockwise, and connect the 400 ohm $\pm 1\%$, 1 watt resistor to the OUTPUT terminals.

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- g. Set FUNCTION switch to METER CURRENT. The Model 341A/343A meter should indicate between 23.7 and 26.3 milliamps.

FAULT ANALYSIS

- (1) If voltage readings are incorrect on one range only, check corresponding range resistor R71, R72, R73 or R74. If voltage readings are incorrect on all ranges, check meter M1 and resistors R44 and R45.
- (2) If current readings are incorrect, check current sensing resistor R70 and associated components.

4-61. MODEL 341A CALIBRATION

4-62. Calibration of the Model 341A consists of five ordered steps: (1) reference voltage adjustment, (2) zero output adjustment, (3) beta string linearity adjustments, (4) range adjustments, and (5) verification of calibration. Before attempting calibration, instrument performance should be examined according to the performance tests in paragraph 4-24 to ensure that no malfunctions exist.

4-63. PRELIMINARY OPERATIONS

- a. Connect the Model 341A to the autotransformer, and adjust the autotransformer for 115 volts output.
- b. Set Model 341A controls as follows:

| | |
|---------------|----------|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage Dials | 10.00000 |

- c. Attach all covers, and allow instrument to operate for at least 1 hour.

4-64. REFERENCE VOLTAGE ADJUSTMENT

- a. Unfasten the top cover and slide back just far enough to expose REF ADJUST control R26 and test point TP2.
- b. Connect the 895A differential voltmeter to TP2, using + SENSE as common.

- c. Adjust R26 for an 895A indication of 15 ± 0.0001 volts dc.
- d. Disconnect the 895A, and position the top cover so that only the beta string calibration controls are exposed.

4-65. ZERO OUTPUT ADJUSTMENTS

- a. Set Model 341A voltage dials to zero, and connect the negative OUTPUT terminal to chassis ground.
- b. Zero the 895A on the 1, volt range, with null sensitivity set to 100 microvolts, then connect the 895A to the Model 341A OUTPUT terminals using low-thermal copper leads.
- c. Set RANGE switch to 10, and adjust the 10V ZERO ADJUST control for zero (± 5 microvolts) indication on the 895A.

WARNING!

Use only an insulated tool for all adjustments within the beta string compartment.

- d. Set RANGE switch to 100, and adjust the 100V ZERO ADJUST control for zero (± 10 microvolts) indication on the 895A.
- e. Set RANGE switch to 1000, and adjust the 1000V ZERO ADJUST control for zero (± 10 microvolts) indication on the 895A.

4-66. BETA STRING LINEARITY ADJUSTMENTS

- a. Set RANGE switch to 100, and connect the 895A to the Model 341A OUTPUT terminals, with the Model 341A negative OUTPUT terminal connected to chassis ground.
- b. Set the Model 341A controls as shown in Figure 4-10 and perform the indicated operations (step c. through step n.).

4-67. RANGE ADJUSTMENTS

- a. Connect the 895A to the OUTPUT terminals, with the Model 341A negative OUTPUT terminal connected to chassis ground.
- b. Set the Model 341A controls as follows:
- | | |
|---------------|----------|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage dials | 10.00000 |

| STEP | VOLTAGE DIAL POSITION | OPERATION |
|------|-----------------------|--|
| c. | 0X.0000 | Record voltage indication within 10 uv. |
| d. | 10.0000 | Adjust 10V LINEARITY to within 50 uv of step c. |
| e. | 1X.0000 | Record voltage indication within 40 uv. |
| f. | 20.0000 | Adjust 20V LINEARITY to within 70 uv of step e. |
| g. | 3X.0000 | Record voltage indication within 40 uv. |
| h. | 40.0000 | Adjust 40V LINEARITY to within 70 uv of step g. |
| i. | 5X.0000 | Record voltage indication within 40 uv. |
| j. | 60.0000 | Adjust 60V LINEARITY to within 70 uv of step i. |
| k. | 7X.0000 | Record voltage indication within 40 uv. |
| l. | 80.0000 | Adjust 80V LINEARITY to within 70 uv of step k. |
| m. | 9X.0000 | Record voltage indication within 40 uv. |
| n. | 100.0000 | Adjust 100V LINEARITY to within 70 uv of step m. |

Figure 4-10. 341A LINEARITY ADJUSTMENTS

- c. Adjust 10V RANGE ADJUST for 10 ± 0.00003 volts indication on the 895A.
- d. Set RANGE switch to 100, and adjust 100V RANGE ADJUST for 100 ± 0.0004 volts indication on the 895A.
- e. Set RANGE switch to 1000 and adjust 1000V RANGE ADJUST for 1000 ± 0.004 volts indication on the 895A.

4-68. CALIBRATION VERIFICATION

4-69. The following measurements should be made immediately following the range adjustments, paragraph 4-67.

- a. Connect the 895A to the OUTPUT terminals, with the Model 341A negative OUTPUT terminal connected to chassis ground.

NOTE!

Use the same 895A that was used for the range adjustments.

- b. Set the Model 341A voltage dials as shown in Figure 4-11. The output voltages should be as indicated in column 1 for an instrument that has just been calibrated. In no case should the output error exceed the tolerances given in column 2, which are derived from instrument specifications found in Section I of the manual.

| RANGE | VOLTAGE DIAL POSITION | OUTPUT— VDC | |
|-------|-----------------------|-----------------|-----------------|
| | | 1 | 2 |
| 10 | 0.00000 | 0 ± 0.00001 | 0 ± 0.00002 |
| 100 | 00.0000 | 0 ± 0.00002 | 0 ± 0.0001 |
| 1000 | 000.000 | 0 ± 0.00006 | 0 ± 0.001 |
| 10 | 10.00000 | 10 ± 0.0002 | 10 ± 0.001 |
| 10 | 5.00000 | 5 ± 0.0002 | 5 ± 0.0005 |
| 100 | 100.0000 | 100 ± 0.002 | 100 ± 0.01 |
| 100 | 50.0000 | 50 ± 0.002 | 50 ± 0.005 |
| 100 | 10.0000 | 10 ± 0.0005 | 10 ± 0.001 |
| 100 | 05.0000 | 5 ± 0.0003 | 5 ± 0.0005 |
| 1000 | 1000.000 | 1000 ± 0.02 | 1000 ± 0.1 |
| 1000 | 500.000 | 500 ± 0.02 | 500 ± 0.05 |
| 1000 | 100.000 | 100 ± 0.005 | 100 ± 0.01 |
| 100 | 050.000 | 50 ± 0.003 | 50 ± 0.005 |

Figure 4-11. 341A OUTPUT VOLTAGE REQUIREMENTS

- c. Calibration of the Model 341A is complete. Set the FUNCTION switch to OFF and disconnect equipment.

4-70. MODEL 343A PRELIMINARY CALIBRATION

4-71. Preliminary calibration of the Model 343A consists of three main steps, ordered as follows: (1) reference voltage adjustment, (2) preliminary zero output and beta string adjustments, and (3) temperature stabilization. Before attempting calibration, instrument performance should be examined according to the performance tests of paragraph 4-24 to ensure that no malfunctions exist.

4-72. PRELIMINARY OPERATIONS

- a. Connect the Model 343A to the autotransformer, and adjust the autotransformer for 115 volts output.
- b. Set the Model 343A controls as follows:

| | |
|---------------|-----------------|
| FUNCTION | ON |
| RANGE | 10 |
| Voltage dials | 10.000000 |
| CURRENT LIMIT | Fully clockwise |

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343A

- c. Attach all covers, and allow instrument to operate for at least 1 hour.

4-73. REFERENCE VOLTAGE ADJUSTMENT

- Unfasten the top cover and slide back just far enough to expose REF ADJUST control R26 and test point TP2.
- Connect the 895A differential voltmeter to TP2, using + SENSE as common.
- Adjust R26 for an 895A indications of 15 ± 0.0001 volts dc.
- Disconnect the 895A, and position the top cover so that only the beta string calibration controls are exposed.

4-74. ZERO OUTPUT ADJUSTMENTS

- Set Model 343A voltage dials to zero, and connect the negative OUTPUT terminal to chassis ground.
- Zero the 895A on the 1 volt range, with null sensitivity set to 100 microvolts, then connect the 895A to the Model 343A OUTPUT terminals using low-thermal copper leads.
- Set RANGE switch to 10, and adjust the 10V ZERO ADJUST control for zero (± 4 microvolts) indication on the 895A.

WARNING!

Use only an insulated tool for all adjustments within the beta string compartment.

- Set RANGE switch to 100, and adjust the 100V ZERO ADJUST control for zero (± 10 microvolts) indication on the 895A.
- Set RANGE switch to 1000, and adjust the 1000V ZERO ADJUST control for zero (± 10 microvolts) indication on the 895A.

4-75. BETA STRING LINEARITY ADJUSTMENTS

- Set RANGE switch to 1000, and connect the 895A to the Model 343A OUTPUT terminals, with the Model 343A negative OUTPUT terminal connected to chassis ground.

- b. Set the Model 343A controls as shown in Figure 4-12, and perform the indicated operations.

| STEP | RANGE | VOLTAGE DIAL POSITION | OPERATION |
|------|-------|-----------------------|--|
| a. | 1000 | 00X.0000 | Record voltage indication within 10 uv. |
| d. | 1000 | 010.0000 | Adjust DECK B 1 to within 10 uv of step c. |
| e. | 1000 | 01X.0000 | Record voltage indication within 30 uv. |
| f. | 1000 | 020.0000 | Adjust DECK B 2 to within 30 uv of step e. |
| g. | 1000 | 03X.0000 | Record voltage indication within 30 uv. |
| h. | 1000 | 040.0000 | Adjust DECK B 4 to within 30 uv of step g. |
| i. | 1000 | 05X.0000 | Record voltage indication within 30 uv. |
| j. | 1000 | 060.0000 | Adjust DECK B 6 to within 40 uv of step i. |
| k. | 1000 | 07X.0000 | Record voltage indication within 40 uv. |
| l. | 1000 | 080.0000 | Adjust DECK B 8 to within 40 uv of step k. |
| m. | 1000 | 09X.0000 | Record voltage indication within 60 uv. |
| n. | 1000 | 0X0.0000 | Adjust DECK B X to within 60 uv of step m. |
| o. | 100 | 0X.00000 | Record voltage indication within 10 uv. |
| p. | 100 | 10.00000 | Adjust DECK A 1 to within 10 uv of step o. |
| q. | 100 | 1X.00000 | Record voltage indication within 30 uv. |
| r. | 100 | 20.00000 | Adjust DECK A 2 to within 30 uv of step q. |
| s. | 100 | 3X.00000 | Record voltage indication within 30 uv. |

Figure 4-12. MODEL 343A PRELIMINARY LINEARITY ADJUSTMENTS (Sheet 1 of 2)

| STEP | RANGE | VOLTAGE DIAL POSITION | OPERATION |
|------|-------|-----------------------|---|
| t. | 100 | 40.00000 | Adjust DECK A 4 to within 30 uv of step s. |
| u. | 100 | 5X.00000 | Record voltage indication within 30 uv. |
| v. | 100 | 60.00000 | Adjust DECK A 6 to within 40 uv of step u. |
| w. | 100 | 7X.00000 | Record voltage indication within 40 uv. |
| x. | 100 | 80.00000 | Adjust DECK A 8 to within 40 uv of step w. |
| y. | 100 | 9X.00000 | Record voltage indication within 60 uv. |
| z. | 100 | 100.00000 | Adjust DECK A 10 to within 60 uv of step y. |

Figure 4-12. MODEL 343A PRELIMINARY LINEARITY ADJUSTMENTS (Sheet 2 of 2)

4-76. TEMPERATURE STABILIZATION

- Install all instrument covers.
- Set RANGE to 100 and voltage dials to 100.00000.
- Operate the instrument continuously for at least 2 hours in an ambient temperature of $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$, prior to beginning final calibration.

4-77. MODEL 343A FINAL CALIBRATION

4-78. Final calibration of the Model 343A consists of the tests and adjustments of paragraphs 4-79 through 4-84. Calibration should be completed without interruption, and control positions should be maintained from step to step unless otherwise instructed.

NOTE!

Ensure that the ambient temperature conditions specified in paragraph 4-76 are maintained throughout the remainder of the Model 343A calibration.

4-79. ZERO OUTPUT ADJUSTMENTS

- Unfasten the top cover and slide back just far enough to expose the beta string calibration controls.

- Connect the 845AR to the Model 343A output terminals, with the Model 343A negative OUTPUT terminal connected to chassis ground.
- Set the Model 343A RANGE to 10 and voltage dials to zero.
- Zero the 845AR on the 1 microvolt range.
- Adjust the 10V ZERO ADJUST control for a null indication (± 2 microvolts) on the 845AR.
- Set the Model 343A RANGE to 100, and adjust the 100V ZERO ADJUST control for a null indication (± 2 microvolts) on the 845AR.
- Set the Model 343A RANGE to 1000, and adjust the 1000V ZERO ADJUST control for a null indication (± 10 microvolts) on the 845AR.

4-80. BETA STRING LINEARITY ADJUSTMENTS

4-81. Deck "B" Adjustments.

- Connect the equipment as shown in Figure 4-13.

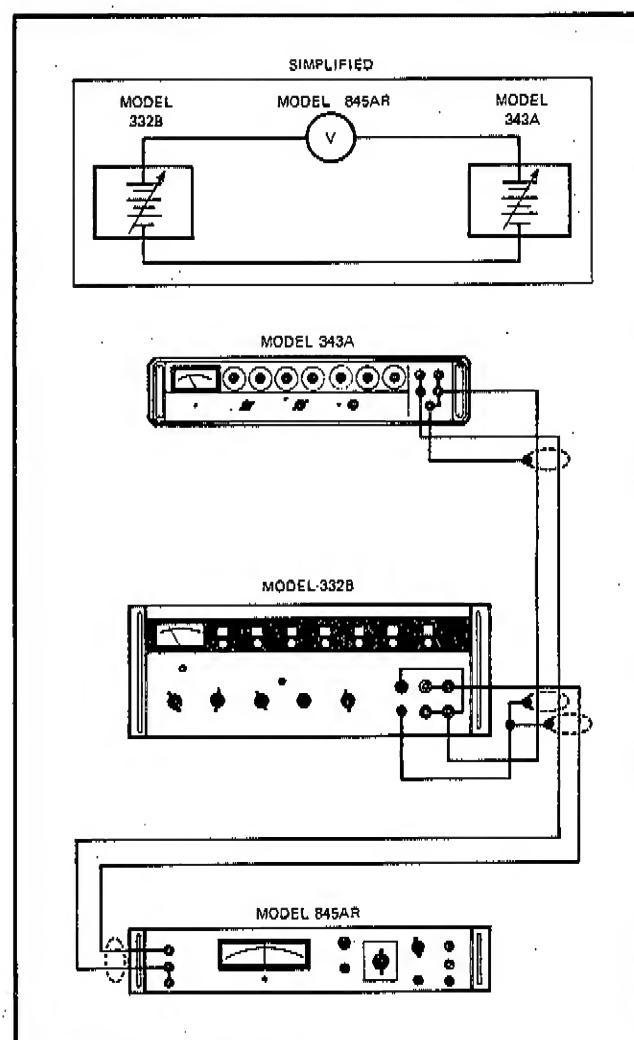


Figure 4-13. BETA STRING LINEARITY TEST SETUP

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343A

- b. Set the 332B VOLTAGE RANGE to 100.
- c. Set the Model 343A and 332B voltage dials as shown in Figure 4-14 and perform the indicated operations.

| STEP | 332B VOLTAGE DIALS | 343A VOLTAGE DIALS | OPERATION |
|------|-----------------------|-----------------------|---|
| d. | 10.00000 | 00X.0000 | Adjust the 332B dials for zero (± 10 uv) on the 845AR. |
| e. | 10.00000 | 010.0000 | Adjust DECK B 1 for an 845AR indication within 10 uv of step d. |
| f. | 20.00000 | 01X.0000 | Adjust the 332B dials for zero (± 10 uv) on the 845AR. |
| g. | 20.00000 | 020.0000 | Adjust DECK B 2 for an 845AR indication within 10 uv of step f. |
| h. | 40.00000 | 03X.0000 | Adjust the 332B dials for zero (± 20 uv) on the 845AR. |
| i. | 40.00000 | 040.0000 | Adjust DECK B 4 for an 845AR indication within 20 uv of step h. |
| j. | 60.00000 | 05X.0000 | Adjust the 332B dials for zero (± 20 uv) on the 845AR. |
| k. | 60.00000 | 060.0000 | Adjust DECK B 6 for an 845AR indication within 20 uv of step j. |
| l. | 80.00000 | 07X.0000 | Adjust the 332B dials for zero (± 40 uv) on the 845AR. |
| m. | 80.00000 | 080.0000 | Adjust DECK B 8 for an 845AR indication within 40 uv of step l. |
| n. | 100.00000 | 09X.0000 | Adjust the 332B dials for zero (± 40 uv) on the 845AR. |
| o. | 100.00000 | 0X0.0000 | Adjust DECK B X for an 845AR indication within 40 uv of step n. |

Figure 4-14. 343A LINEARITY ADJUSTMENTS-DECK B

4-82. Deck "A" Adjustments

- a. Set the Model 343A and 332B RANGE to 100.
- b. Set the Model 343A and 332B voltage dials as shown in Figure 4-15 and perform the indicated operations.

| STEP | 332B VOLTAGE DIALS | 343A VOLTAGE DIALS | OPERATION |
|------|-----------------------|-----------------------|--|
| c. | 10.00000 | 0X.0000 | Adjust the 332B dials for zero (± 10 uv) on the 845AR. |
| d. | 10.00000 | 10.0000 | Adjust DECK A 1 for an 845AR indication within 10 uv of step c. |
| e. | 20.00000 | 1X.0000 | Adjust the 332B dials for zero (± 10 uv) on the 845AR. |
| f. | 20.00000 | 20.0000 | Adjust DECK A 2 for an 845AR indication within 10 uv of step e. |
| g. | 40.00000 | 3X.0000 | Adjust the 332B dials for zero (± 20 uv) on the 845AR. |
| h. | 40.00000 | 40.0000 | Adjust DECK A 4 for an 845AR indication within 20 uv of step g. |
| i. | 60.00000 | 5X.0000 | Adjust the 332B dials for zero (± 20 uv) on the 845AR. |
| j. | 60.00000 | 60.0000 | Adjust DECK A 6 for an 845AR indication within 20 uv of step i. |
| k. | 80.00000 | 7X.0000 | Adjust the 332B dials for zero (± 40 uv) on the 845AR. |
| l. | 80.00000 | 80.0000 | Adjust DECK A 8 for an 845AR indication within 40 uv of step k. |
| m. | 100.00000 | 9X.0000 | Adjust the 332B dials for zero (± 40 uv) on the 845AR. |
| n. | 100.00000 | 100.0000 | Adjust DECK A 10 for an 845AR indication within 40 uv of step m. |

Figure 4-15. 343A LINEARITY ADJUSTMENTS-DECK A

- o. Set Model 343A and 332B voltage controls for zero volts output.

4-83. RANGE ADJUSTMENTS

- a. Connect equipment as shown in Figure 4-16.
b. Set the Model 343A controls as follows:

| | |
|---------------|--------------------|
| RANGE | 10 |
| Voltage dials | <u>10.000000</u> |
| CURRENT LIMIT | Approximately 5 ma |

- c. Set the 750A input and output switches to 10.

- d. Adjust the 332B controls for 10 volts output.
e. Set the 750A standard cell circuit switch to MOMENTARY and adjust the 332B controls for zero (± 1 microvolt) on 845AR No. 1.
f. Adjust the 10V RANGE ADJUST control for zero (± 10 microvolts) on 845AR No. 2.
g. Set the Model 343A RANGE to 100 and voltage dials to 100.00000.
h. Set the 750A input and output switches to 100.
i. Adjust the 332B controls for 100 volts output.

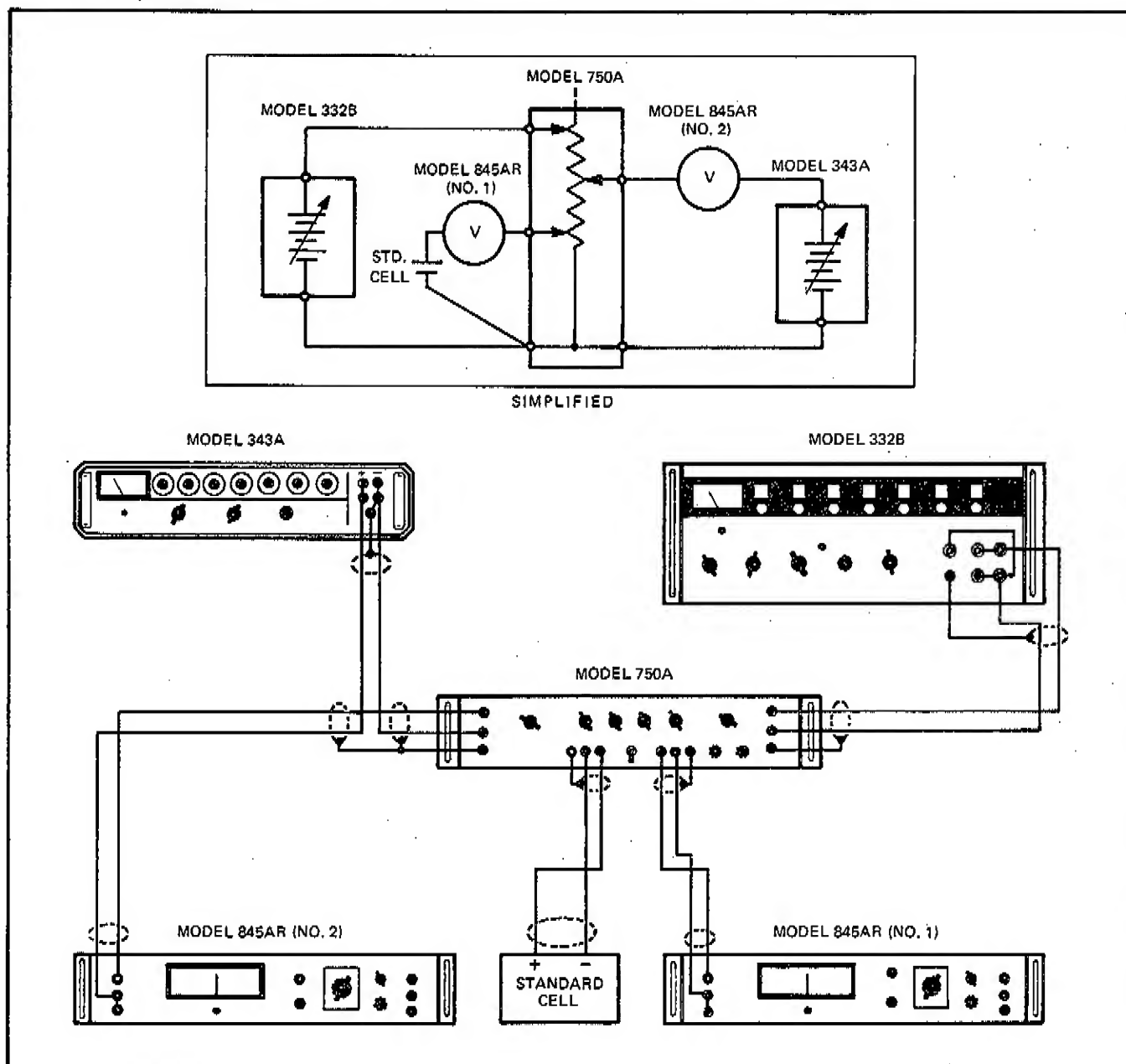


Figure 4-16. RANGE ADJUSTMENT AND CALIBRATION VERIFICATION TEST SETUP

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343A

- j. Repeat step e.
- k. Adjust the 100V RANGE ADJUST control for zero (± 100 microvolts) on 845AR No. 2.
- l. Set the 343A RANGE to 1000 and voltage dials to 1000.0000.
- m. Set the 750A input and output switches to 1000.
- n. Adjust the 332B controls for 1000 volts output.
- o. Repeat step e.
- p. Adjust the 1000V RANGE ADJUST control for zero (± 1 millivolt) on 845AR No. 1.

NOTE!

Allow the Model 343A to stabilize (approximately 5 minutes) before making the 1000 volt range adjustment.

4-84. CALIBRATION VERIFICATION

4-85. The following test should be performed immediately following Model 343A calibration.

- a. Leave equipment connected as shown in Figure 4-16.
- b. Perform the 750A standardization, paragraph 4-83, step e. Set the equipment controls as shown in Figure 4-17. The null indication obtained in each step should be within the indicated tolerance.

NOTE!

The null tolerances listed in column 1 (Figure 4-17) apply to those instruments which have just been calibrated; in no case should the output error exceed the tolerances given in column 2, which are derived from instrument specifications found in Section I of the manual.

- c. Set the Model 343A voltage dials to zero.
- d. Disconnect the 750A from the Model 343A OUTPUT terminals, and connect the 845AR directly to the Model 343A OUTPUT terminals. Ensure that the negative OUTPUT terminal is connected to chassis ground.
- e. Zero the 845AR on the 1 microvolt range.
- f. Set the Model 343A RANGE to 10 and voltage dials to zero. The 845AR should indicate zero (± 5 microvolts).
- g. Set the Model 343A RANGE to 100. The 845AR should indicate zero (± 5 microvolts).
- h. Set the Model 343A RANGE to 1000. The 845AR should indicate zero (± 20 microvolts).
- i. Calibration of the Model 343A is complete. Set the FUNCTION switch to OFF and disconnect equipment.

| 750A | | 332B OUTPUT VOLTS | 343A | | 845AR NO. 2 NULL TOLERANCE | |
|-------|--------|----------------------|-------|------------------|-------------------------------|--------|
| INPUT | OUTPUT | | RANGE | VOLTAGE DIALS | 1 | 2 |
| 10 | 1.0 | 10 | 10 | 1.000000 | 10 uv | 30 uv |
| 10 | 5 | 10 | 10 | 5.000000 | 50 uv | 150 uv |
| 10 | 10 | 10 | 10 | <u>10.000000</u> | 100 uv | 300 uv |
| 100 | 10 | 100 | 100 | 0X.00000 | 100 uv | 300 uv |
| 100 | 50 | 100 | 100 | 50.00000 | 100 uv | 1.5 mv |
| 100 | 100 | 100 | 100 | <u>100.00000</u> | 100 uv | 3 mv |
| 1000 | 100 | 1000 | 1000 | 100.0000 | 100 uv | 3 mv |
| 1000 | 500 | 1000 | 1000 | 500.0000 | 100 uv | 15 mv |
| 1000 | 1000 | 1000 | 1000 | <u>1000.0000</u> | 100 uv | 30 mv |

Figure 4-17. MODEL 343A OUTPUT VOLTAGE REQUIREMENTS

SECTION V

LIST OF REPLACEABLE PARTS

5-1. INTRODUCTION

5-2. This section of the manual contains a listing of replaceable components for this instrument. The first listing contains a complete breakdown of all the major assemblies followed by subsequent listings that itemize the components on each major assembly. An illustration accompanies each major assembly listing to aid in locating the listed components.

5-3. Assemblies and subassemblies are identified by a reference designation beginning with the letter A followed by a number (e.g., A1 etc.). Electrical components appearing on the schematic diagram are identified by their schematic diagram reference designation. Components not appearing on the schematic diagram are consecutively numbered throughout the parts list. These components are identified with whole numbers on the arrow call-out illustrations and by index numbers on the grid illustrations. Flagnotes are used throughout the parts list and refer to special ordering explanations that are located in close proximity to the flagnotes.

5-4. COLUMN DESCRIPTION

- a. The REF DESIG column indexes the item description to the associated illustration. In general the reference designations are listed under each assembly in alpha-numeric order. Subassemblies of minor proportions are sometimes listed with the assembly of which they are a part. In this case, the reference designations for the components of the subassembly may appear out of order.
- b. The INDEX NO. column lists coordinates which locate the designated part on the associated grid illustrations.
- c. The DESCRIPTION column describes the salient characteristics of the component. Indentation of the description indicates the relationship to other assemblies, components, etc. In many cases it is necessary to abbreviate in this column. For abbreviations and symbols used, see the following page.
- d. The ten-digit part number, by which the item is identified at the John Fluke Mfg. Co., is listed in the STOCK NO. column. Use this number when ordering parts from the factory or authorized representatives.
- e. The Federal Supply Code for the item manufacturer is listed in the MFR column. An abbreviated list of Federal Supply Codes is included in the Appendix.
- f. The part number which uniquely identifies the item to the original manufacturer is listed in the MFR PART NO. column. If a component must be ordered by description, the type number is listed.
- g. The TOT QTY column lists the total quantity of the items used in the instrument and reflects the latest Use Code. Second and subsequent listings of the same item are referenced to the first listing with the abbreviation REF. In the case of optional subassemblies, plug ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the TOT QTY column lists the total quantity of the item in that particular assembly.
- h. Entries in the REC QTY column indicate the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of every part in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc. that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.
- i. The USE CODE column identifies certain parts which have been added, deleted or modified during the production of the instrument. Each part for which a Use Code has been assigned may be identified with a particular instrument serial number

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by consulting the Serial Number Effectivity List at the end of the parts list. Sometimes when a part is changed, the new part can and should be used as a replacement for the original part. In this event a parenthetical note is added in the DESCRIPTION column.

5-5. HOW TO OBTAIN PARTS

5-6. Standard components have been used wherever possible. Standard components may be ordered directly from the manufacturer by using the manufacturer's part number, or parts may be ordered from the John Fluke Mfg. Co. factory or authorized representative by using the Fluke part number. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

5-7. You can insure prompt and efficient handling of your order to the John Fluke Mfg. Co. if you include the following information:

- a. Quantity.
- b. FLUKE Stock Number.
- c. Description.
- d. Reference Designation.
- e. Instrument model and serial number.

Example: 2 each, 4805-177105, Transistors, 2N3565, Q107-108 for 845AR, s/n 168.

If you must order structural parts not listed in the parts list, describe the part as completely as possible. A sketch of the part, showing its location to other parts of the instrument, is usually most helpful.

5-8. LIST OF ABBREVIATIONS

| | | | | | |
|---------|---------------------------|----------|----------------------|------|------------------------------|
| ac | alternating current | MHz | megahertz | rf | radio frequency |
| Al | Aluminum | M | megohm | rfi | radio frequency interference |
| amp | ampere | met flm | metal film | res | resistor |
| assy | assembly | ua | microampere | rms | root mean square |
| cap | capacitor | uf | microfarad | rtry | rotary |
| car flm | carbon film | uh | microhenry | sec | second |
| C | centigrade | usec | microsecond | sect | section |
| cer | ceramic | uv | microvolt | S/N | serial number |
| comp | composition | ma | millampere | Si | silicon |
| conn | connector | mh | millihenry | scr | silicon controlled rectifier |
| db | decibel | m | milliohms | spdt | single-pole, double-throw |
| dc | direct current | msec | millisecond | spst | single-pole, single-throw |
| dpdt | double-pole, double-throw | mv | millivolt | sw | switch |
| dpst | double-pole, single-throw | mw | milliwatt | Ta | tantalum |
| elect | electrolytic | na | nanoampere | tstr | transistor |
| F | fahrenheit | nsec | nanosecond | tvm | transistor voltmeter |
| Ge | germanium | nv | nanovolt | uhf | ultra high frequency |
| gmV | guaranteed minimum value | Ω | ohm | vtvm | vacuum tube voltmeter |
| h | henry | ppm | parts per million | var | variable |
| Hz | hertz | piv | peak inverse voltage | vlf | very low frequency |
| hf | high frequency | p-p | peak to peak | v | volt |
| IC | integrated circuit | pf | picofarad | va | voltampere |
| if | intermediate frequency | plstc | plastic | vac | volts, alternating current |
| k | kilohm | p | pole | vdc | volts, direct current |
| kHz | kilohertz | pos | position | w | watt |
| kv | kilovolt | P/C | printed circuit | ww | wire wound |
| lf | low frequency | | | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|----------------------------|----------------|----------------------------|------------|------------|-------------|
| | | DC VOLTAGE CALIBRATOR Figure 5-1 | 341A | | | | | |
| A1 | | Front Panel Assembly (See Figure- 5-2) | | | | | | |
| A2 | | Rear Panel Assembly (See Figure 5-3) | | | | | | |
| A3 | | Main P/C Assembly (See Figures 5-4 & 5-5) | 1702-240143 | 89536 | 1702-240143 | 1 | | |
| A4 | | Reference P/C Assembly (See Figure 5-6) | 3158-240101 | 89536 | 3158-240101 | 1 | | |
| A5 | | Sample String P/C Assembly (See Figure 5-7) | 3158-263012 | 89536 | 3158-263012 | 1 | | |
| C49 | | Cap, oil, 1 uf $\pm 10\%$, 1500v | 1505-247023 | 56289 | 264P70 | 1 | | |
| C62 | | Cap, cer, 1 uf, gmv, 3v | 1501-106567 | 14655 | HCC3105P | 3 | | |
| C66 | | Cap, plstc, 0.047 uf $\pm 20\%$, 1600v | 1507-246694 | 84411 | Type 663 UW | 1 | | |
| CR58 | | Diode, silicon, 1 amp, 100 piv | 4802-116111 | 05277 | IN4817 | 25 | | |
| M1 | | Meter, 0-1.0v, 0-30 ma | 2901-246942 | 89536 | 2901-246942 | 1 | | |
| R41 | | Res, var, comp, 5k $\pm 10\%$, 3w | 4701-247031 | 71450 | 321S502A | 1 | | |
| R177 | | Res, comp, 1 Ω $\pm 5\%$, 1/2w | 4704-218693 | 01121 | EB10G5 | 1 | | |
| S1 | | Switch, rotary, Decade 1 Switch section, decks A & B Switch section, decks C & D | 5105-257238 5105-257246 | 89536 89536 | 5105-257238 5105-257246 | 1 1 | | |
| S8 | | Switch, rotary, FUNCTION | 5105-257261 | 89536 | 5105-257261 | 1 | | |
| S9 | | Switch, rotary, RANGE Switch section, decks A & B Switch section, decks C & D | 5105-257212 5105-257220 | 89536 89536 | 5105-257212 5105-257220 | 1 1 | | |
| T1 | | Transformer, power | 5602-240465 | 89536 | 5602-240465 | 1 | | |
| 1 | | Bail, tilt-down (not illustrated) | 3154-231407 | 89536 | 3154-231407 | 1 | | |
| 2 | | Cover, bottom (not illustrated) | 3156-240382 | 89536 | 3156-240382 | 1 | | |
| 3 | | Cover, top (not illustrated) | 3156-240374 | 89536 | 3156-240374 | 1 | | |
| 4 | | Detent, switch, S1 | 5105-257287 | 89536 | 5105-257287 | 1 | | |
| 5 | | Detent, switch, S2 thru S6 | 5105-257295 | 89536 | 5105-257295 | 5 | | |
| 6 | | Detent, switch, S9 | 5105-257279 | 89536 | 5105-257279 | 1 | | |
| 7 | | Foot (not illustrated) | 3155-230037 | 89536 | 3155-230037 | 4 | | |
| 8 | | Shaft extension, S2 thru S6 | 3155-240457 | 89536 | 3155-240457 | 5 | | |

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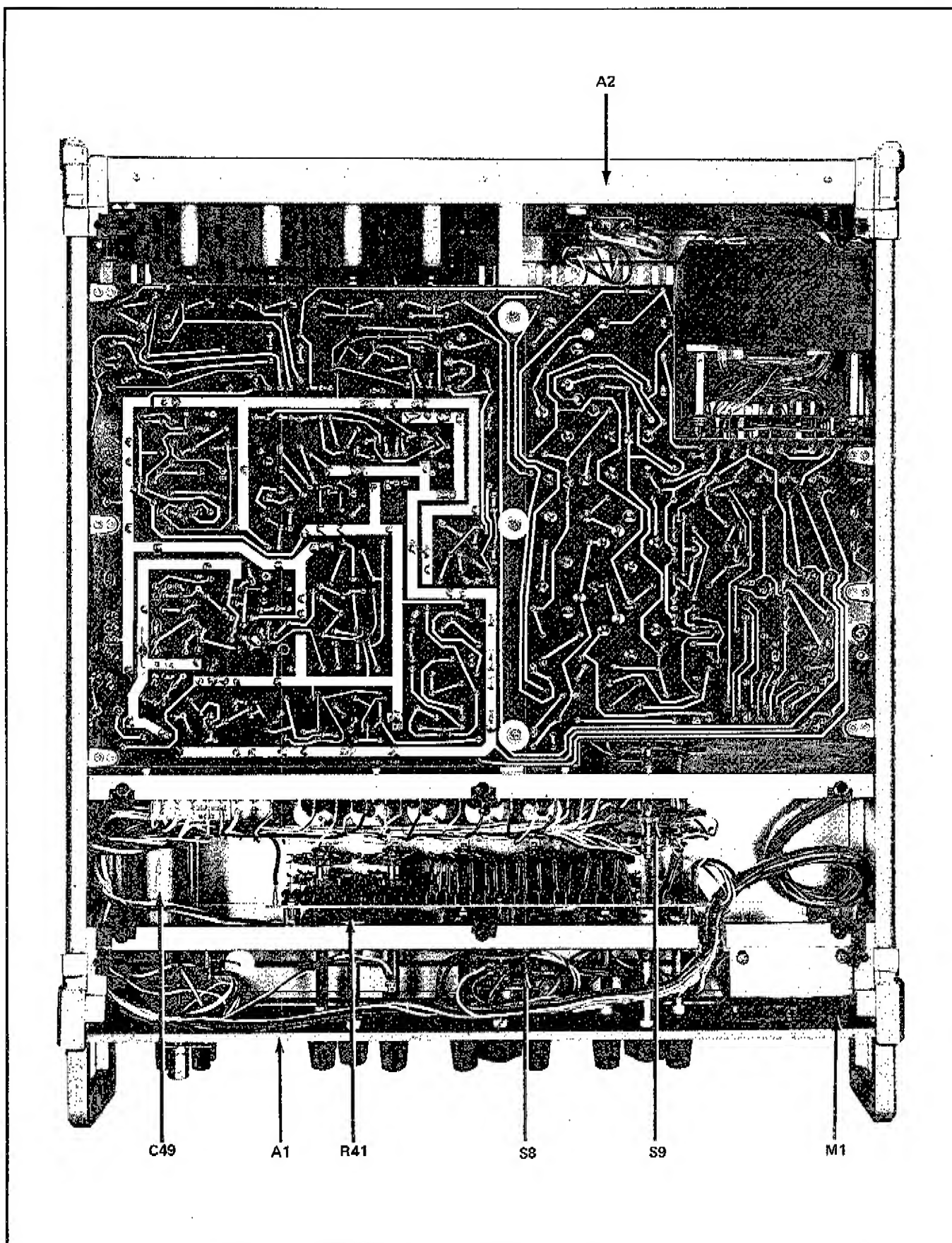


Figure 5-1. 341A DC VOLTAGE CALIBRATOR (Sheet 1 of 2)

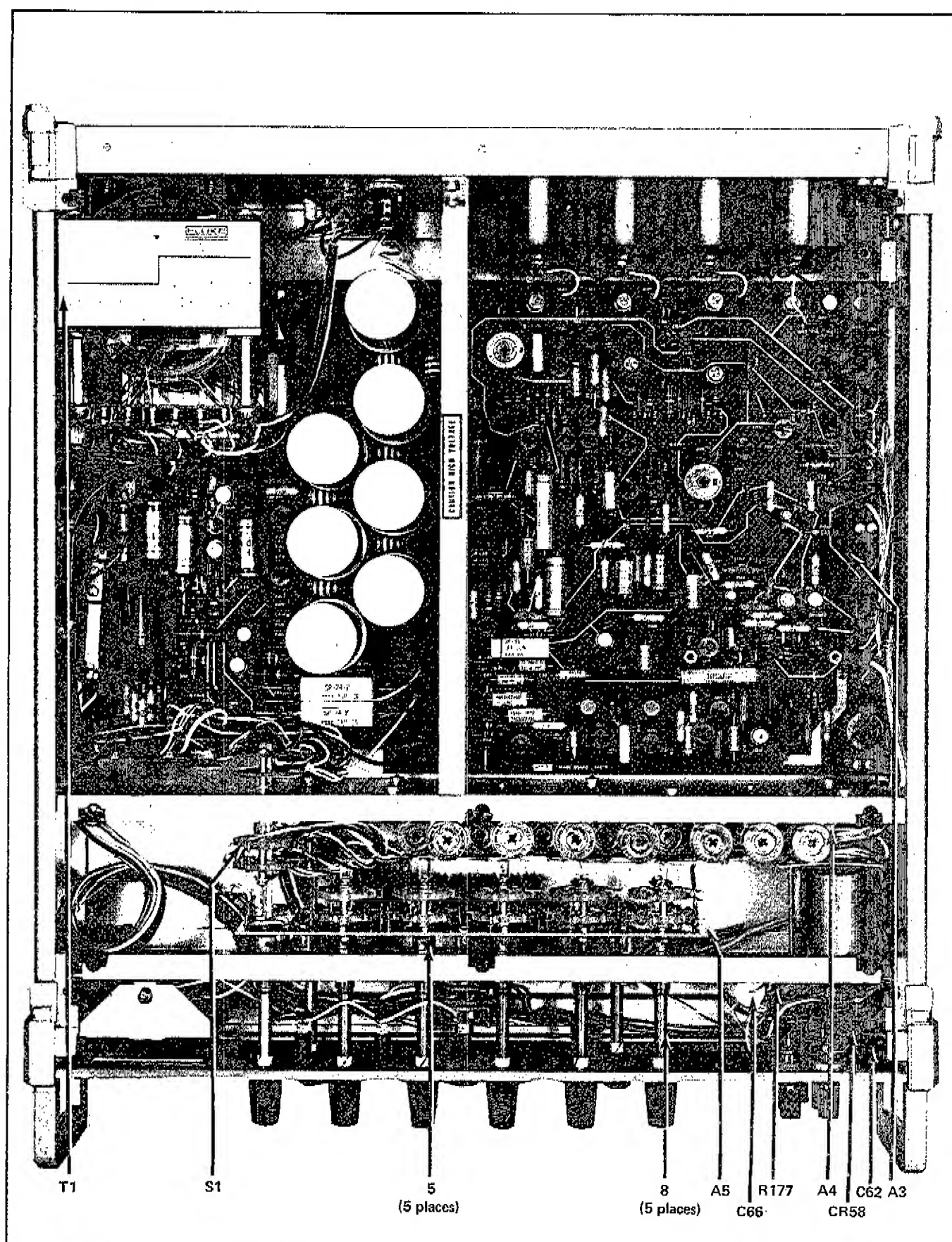


Figure 5-1. 341A DC VOLTAGE CALIBRATOR (Sheet 2 of 2)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|----------------------|-------------|---|-------------|-------|----------------|------------|------------|-------------|
| A1 | | FRONT PANEL ASSEMBLY (341A) Figure 5-2 | | | | | | |
| DS3 thru DS7 | | Lamp, incandescent, 28v | 3901-246686 | 08806 | 7387 | 5 | 2 | |
| J1, J2 | | Binding post, red | 2811-226308 | 58474 | DF21RC | 2 | | |
| J3, J4 | | Binding post, black | 2811-226282 | 58474 | DF21BC | 2 | | |
| J5 | | Binding post, white | 2811-261156 | 58474 | DF21WTC | 1 | | |
| XDS3 thru XDS7 | | Holder, lamp | 3155-252411 | 89536 | 3155-252411 | 5 | | |
| 9 | | Handle | 2404-246306 | 89536 | 2404-246306 | 2 | | |
| 10 | | Knob, CURRENT LIMIT | 2405-190249 | 89536 | 2405-190249 | 1 | | |
| 11 | | Knob, DIGIT, 0-X | 3155-252353 | 89536 | 3155-252353 | 5 | | |
| 12 | | Knob, DIGIT, 0-10 | 3155-252361 | 89536 | 3155-252361 | 1 | | |
| 13 | | Knob, FUNCTION, RANGE | 2405-158956 | 89536 | 2405-158956 | 2 | | |
| 14 | | Lens, lamp, clear | 3155-222596 | 89536 | 3155-222596 | 3 | | |
| 15 | | Lens, lamp, red | 3155-228056 | 89536 | 3155-228056 | 2 | | |
| 16 | | Link, Shorting | 2811-101220 | 24655 | 0938-9712 | 3 | | |
| 17 | | Panel, Front | 1406-240267 | 89536 | 1406-240267 | 1 | | |

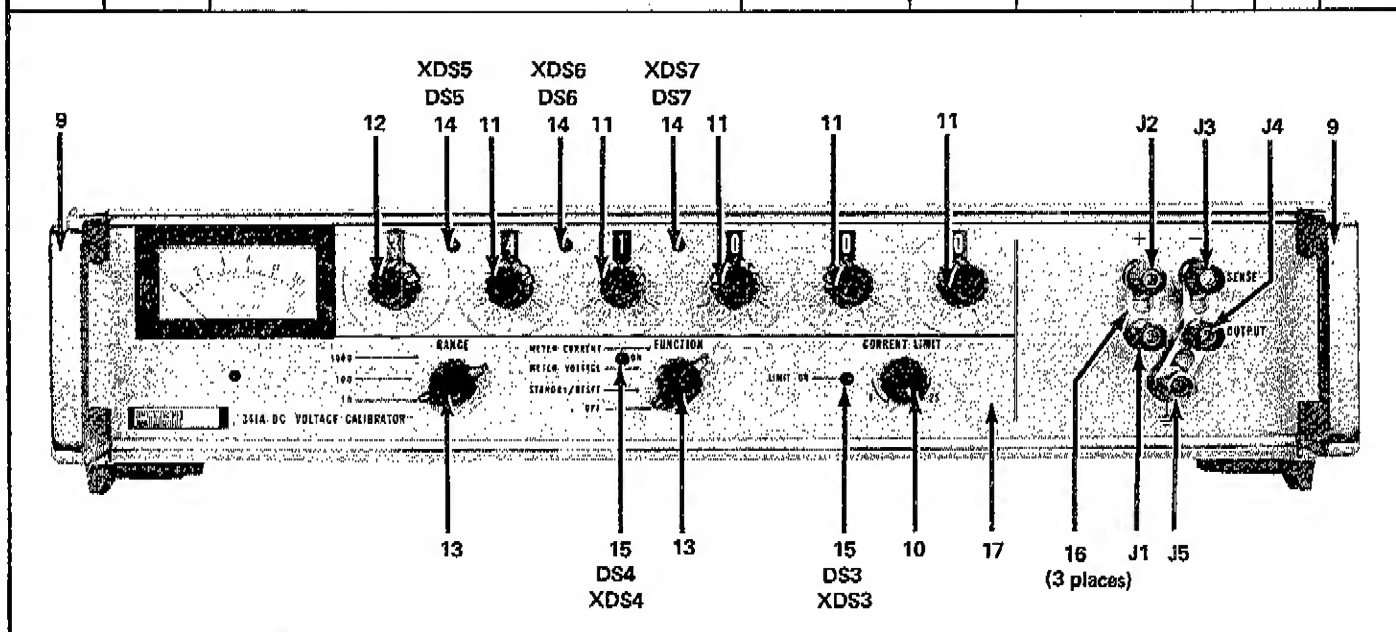


Figure 5-2. FRONT PANEL ASSEMBLY (341A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|-----------------------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| A2 | | REAR PANEL ASSEMBLY (341A) Figure 5-3 | | | | | | |
| C59, C60 | | Cap, cer, 0.01 uf +80/-20%, 500v | 1501-105668 | 56289 | 29C9B5 | 3 | | |
| F1 | | Fuse, slow blow, 1 amp, 250v (for 115v operation) | 5101-109272 | 71400 | Type MDL | 1 | 3 | |
| F1 | | Fuse, slow blow, 1/2 amp, 250v (for 230v operation) | 5101-109322 | 71400 | Type MDL | 1 | 3 | |
| F2 | | Fuse, slow blow, 1/16 amp, 250v | 5101-163030 | 71400 | Type MDL | 1 | 3 | |
| Q42, Q44, Q46, Q48 | | Tstr, silicon, NPN (behind heat sinks) | 4811-190710 | 04713 | 2N3739 | 4 | 4 | |
| W1 | | Line cord | 6005-226027 | 89536 | 6005-226027 | 1 | | |
| XF1, XF2 | | Holder, Fuse | 2102-160846 | 75915 | 342004 | 2 | | |
| 18 | | Heat sink | 3156-240432 | 89536 | 3156-240432 | 4 | | |
| 19 | | Panel, rear | 3156-240309 | 89536 | 3156-240309 | 1 | | |

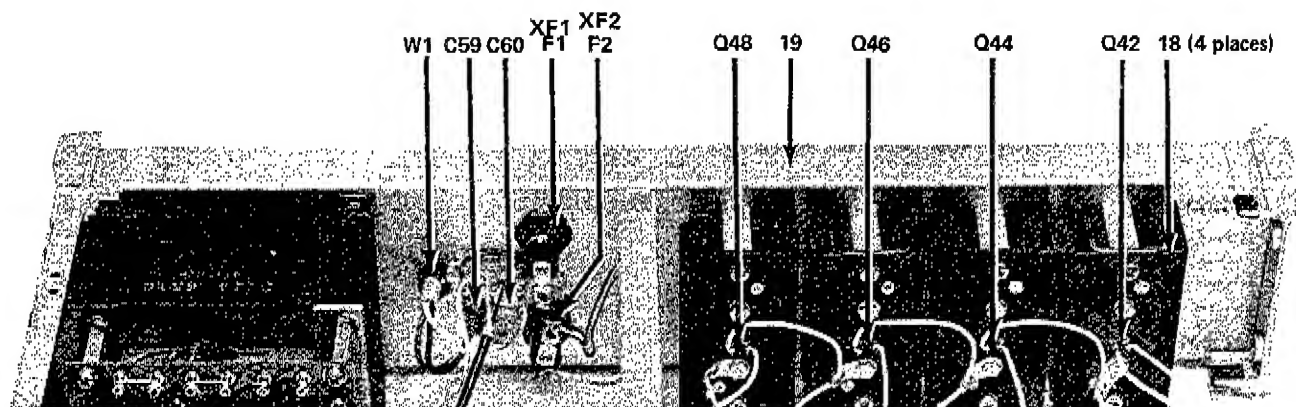


Figure 5-3. REAR PANEL ASSEMBLY (341A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|-------------|-------|------------------|------------|------------|-------------|
| A3 | | MAIN P/C ASSEMBLY Figure 5-4 & 5-5 | | | | | | |
| | | Model 341A only | 1702-240143 | 89536 | 1702-240143 | REF | | |
| | | Model 343A only | 1702-265322 | 89536 | 1702-265322 | REF | | |
| C1 | E3-U3 | Cap, elect, 80 uf +50/-10%, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | 6 | 1 | |
| C2 | K3-U3 | Cap, elect, 80 uf +50/-10%, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | REF | | |
| C3 | H3-T1 | Cap, elect, 200 uf +50/-10%, 250v (Fig. 5-4) | 1502-246827 | 56289 | Type 68D | 1 | | |
| C4 | H1-Q5 | Cap, cer, 1 uf, gm, 3v (Fig. 5-4) | 1501-106567 | 14655 | HCC3105P | REF | | |
| C5 | E1-P1 | Cap, elect, 250 uf +50/-10%, 16v (Fig. 5-4) | 1502-187765 | 73445 | C437ARE250 | 2 | | |
| C7 | G4-M5 | Cap, elect, 10 uf +50/-10%, 25v (Fig. 5-5) | 1502-170266 | 73445 | C426ARF10 | 4 | | |
| C8 | E3-S1 | Cap, mica, 4 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-190397 | 14655 | CD15C040K | 1 | | |
| C9 | G3-R3 | Cap, plstc, 0.1 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-161992 | 73445 | C280AE/ P100K | 3 | | |
| C10 | H3-M3 | Cap, plstc, 0.015 uf $\pm 2\%$, 100v (Fig. 5-5) | 1507-233577 | 02799 | 1PC153G | 2 | | |
| C11 | F3-N3 | Cap, plstc, 0.015 uf $\pm 2\%$, 100v (Fig. 5-5) | 1507-233577 | 02799 | 1PC153G | REF | | |
| C14 | G4-Q1 | Cap, plstc, 0.47 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-184366 | 73445 | C280AE/ P470K | 3 | | |
| C15 | H1-N3 | Cap, plstc, 0.22 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-194803 | 73445 | C230AE/ P220K | 1 | | |
| C16 | D1-S3 | Cap, elect, 100 uf +75/-10%, 25v (Fig. 5-5) | 1502-106518 | 80183 | TE1211 | 2 | | |
| C17 | G2-N5 | Cap, elect, 100 uf +75/-10%, 25v (Fig. 5-5) | 1502-106518 | 80183 | TE1211 | REF | | |
| C18 | B5-S4 | Cap, elect, 5 uf +75/-10%, 25v (Fig. 5-5) | 1502-152009 | 80183 | TE1202 | 3 | | |
| C19 | J1-P3 | Cap, elect, 10 uf +50/-10%, 25v (Fig. 5-5) | 1502-170266 | 73445 | C426ARF10 | REF | | |
| C20 | B4-Q3 | Cap, plstc, 0.47uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-184366 | 73445 | C230AE/ P470K | REF | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|-------------|-------|------------------|------------|------------|-------------|
| C21 | J3-N4 | Cap, plstc, 0.47 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-184366 | 73445 | C280AE/ P470K | REF | | |
| C22 | F4-P2 | Cap, elect, 250 uf $+50/-10\%$, 40v (Fig. 5-4) | 1502-178616 | 73445 | C437ARG250 | 3 | 1 | |
| C23 | F4-N4 | Cap, elect, 250 uf $+50/-10\%$, 40v (Fig. 5-4) | 1502-178616 | 73445 | C437ARG250 | REF | | |
| C24 | F3-Q1 | Cap, elect, 250 uf $+50/-10\%$, 40v (Fig. 5-4) | 1502-178616 | 73445 | C437ARG250 | REF | | |
| C25 | F3-R3 | Cap, elect, 400 uf $+50/-10\%$, 25v (Fig. 5-4) | 1502-168153 | 73445 | C437ARF400 | 1 | | |
| C26 | G5-U3 | Cap, mica, 220 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-170423 | 14655 | CD15F221J | 2 | | |
| C27 | I5-S5 | Cap, mica, 68 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-148510 | 14655 | CD15F680J | 1 | | |
| C28 | H2-U3 | Cap, elect, 10 uf $+50/-10\%$, 25v (Fig. 5-5) | 1502-170266 | 73445 | C426ARF10 | REF | | |
| C29 | H4-U3 | Cap, elect, 10 uf $+50/10\%$, 25v (Fig. 5-5) | 1502-170266 | 73445 | C426ARF10 | REF | | |
| C30 | E4-T2 | Cap, plstc, 0.1 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-161992 | 73445 | C280AE/ P100K | REF | | |
| C31 | F1-P1 | Cap, elect, 250 uf $+50/-10\%$, 16v (Fig. 5-5) | 1502-187765 | 73445 | C437ARE250 | REF | | |
| C32 | D4-N2 | Cap, plstc, 0.33 uf $\pm 10\%$, 200v (Fig. 5-5) | 1507-106047 | 72928 | 355C334K | 1 | | |
| C33 | D2-N4 | Cap, elect, 15 uf $+75/-10\%$, 6v (Fig. 5-5) | 1502-105700 | 80183 | TE1089 | 2 | | |
| C34 | D1-N2 | Cap, elect, 15 uf $+75/-10\%$, 6v (Fig. 5-5) | 1502-105700 | 80183 | TE1089 | REF | | |
| C35 | C2-N3 | Cap, elect, 30 uf $+75/-10\%$, 15v (Fig. 5-5) | 1502-106492 | 80183 | TE1158 | 2 | | |
| C36 | C4-N2 | Cap, elect, 30 uf $+75/-10\%$, 15v (Fig. 5-5) | 1502-106492 | 80183 | TE1158 | REF | | |
| C37 | D1-P3 | Cap, elect, 5 uf $+75/-10\%$, 25v (Fig. 5-5) | 1502-152009 | 80183 | TE1202 | REF | | |
| C38 | E5-P5 | Cap, mica, 5 pf $\pm 10\%$, 500v (Fig. 5-5) | 1504-148577 | 14655 | CD15C050K | 1 | | |
| C39 | E5-Q2 | Cap, mica, 220 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-170423 | 14655 | CD15F221J | REF | | |

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|------------------|------------|------------|-------------|
| C40 | D4-Q4 | Cap, mica, 100 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-148494 | 14655 | CD15F101J | 2 | | |
| C41 | E3-R1 | Cap, mica, 620 pf $\pm 5\%$, 500v (Fig. 5-5) | 1504-215244 | 14655 | CD19F621J | 1 | | |
| C42 | D3-Q5 | Cap, elect, 5 uf $+75/-10\%$, 25v (Fig. 5-5) | 1502-152009 | 80183 | TE1202 | REF | | |
| C43 | F1-Q3 | Cap, elect, 100 uf $+75/-10\%$, 3v (Fig. 5-5) | 1502-106534 | 80183 | TE1059-5 | 2 | | |
| C44 | F1-R1 | Cap, elect, 50 uf $+50/-10\%$, 25v (Fig. 5-5) | 1502-168823 | 73445 | C426ARF50 | 1 | | |
| C45 | E4-R5 | Cap, elect, 100 uf $+75/-10\%$, 3v (Fig. 5-5) | 1502-106534 | 80183 | TE1059-5 | REF | | |
| C46 | D5-S3 | Cap, plstc, 0.047 uf $\pm 20\%$, 200v (Fig. 5-5) | 1507-162008 | 73445 | C280AE/ P47K | 1 | | |
| C47 | E2-U3 | Cap, plstc, 0.1 uf $\pm 20\%$, 250v (Fig. 5-5) | 1507-161992 | 73445 | C280AE/ P100K | REF | | |
| C48 | G2-M5 | Cap, cer, 0.01 uf, gm, 1.6 kv (Fig. 5-4) | 1501-106930 | 71590 | DD16-103 | 4 | | |
| C51 | J5-U2 | Cap, cer, 0.0012 uf $\pm 10\%$, 500v (Fig. 5-5) | 1501-106732 | 71590 | CF-22 | 1 | | |
| C52 | B4-U3 | Cap, cer, 0.01 uf, gm, 1.6kv (Fig. 5-4) | 1501-106930 | 71590 | DD16-103 | REF | | |
| C53 | A5-V1 | Cap, cer, 0.01 uf, gm, 1.6kv (Fig. 5-4) | 1501-106930 | 71590 | DD16-103 | REF | | |
| C54 | H3-V1 | Cap, cer, 0.005 uf $\pm 20\%$, 3kv (Fig. 5-4) | 1501-188003 | 71590 | 2DDH6R502M | 1 | | |
| C55 | G3-U3 | Cap, elect, 80 uf $+50/-10\%$, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | REF | | |
| C56 | F3-T1 | Cap, elect, 80 uf $+50/-10\%$, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | REF | | |
| C57 | E3-U3 | Cap, elect, 80 uf $+50/-10\%$, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | REF | | |
| C58 | D3-T1 | Cap, elect, 80 uf $+50/-10\%$, 450v (Fig. 5-4) | 1502-246819 | 56289 | Type 68D | REF | | |
| C61 | E4-R5 | Cap, mica, 100 pf $\pm 5\%$, 500v (Fig. 5-4) | 1504-148494 | 14655 | CD15F101J | REF | | |
| C63 | C4-V2 | Cap, cer, 1 uf, gm, 3v(Fig. 5-5) | 1501-106567 | 14655 | HCC3105P | REF | | |
| C64 | J2-T4 | Cap, cer, 0.01 uf $+80/-10\%$, 500v (Fig. 5-4) | 1501-105668 | 56289 | 29C9B5 | REF | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| C65 | K3-S1 | Cap, cer, 0.01 uf, gmv, 1.6-kv (Fig. 5-4) | 1501-106930 | 71590 | DD16-103 | REF | | |
| C67 | C2-Q2 | Cap, cer, 500 pf $\pm 10\%$, 1 kv (Fig. 5-5) | 1501-105692 | 71590 | 2DDH60N501K | 1 | | |
| CR1 | J2-S2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | 12 | 2 | |
| CR2 | K1-S2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR3 | H3-R1 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR4 | I4-S2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR5 | K5-S2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR6 | G3-Q3 | Diode, silicon, 150 ma (Fig. 5-4) | 4805-203323 | 03508 | DHD1105 | 10 | | |
| CR7 | H5-Q1 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR8 | D4-N5 | Diode, silicon, 150 ma (Fig. 5-4) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR9 | F4-M4 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR10 | I4-M3 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR11 | F4-N1 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR12 | F2-M4 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR17 | B5-P3 | Diode, zener, 18v (Fig. 5-5) | 4809-113365 | 04713 | 1N3026A | 1 | 1 | |
| CR19 | B5-Q2 | Diode, zener, 12v (Fig. 5-5) | 4809-249052 | 07910 | 1N963B | 2 | | |
| CR20 | B4-Q2 | Diode, zener, 12v (Fig. 5-5) | 4809-249052 | 07910 | 1N963B | REF | | |
| CR21 | J5-N3 | Diode, zener, 6.8v (Fig. 5-5) | 4809-166199 | 07910 | 1N754 | 1 | | |
| CR22 | H2-N5 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR23 | H2-P4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |

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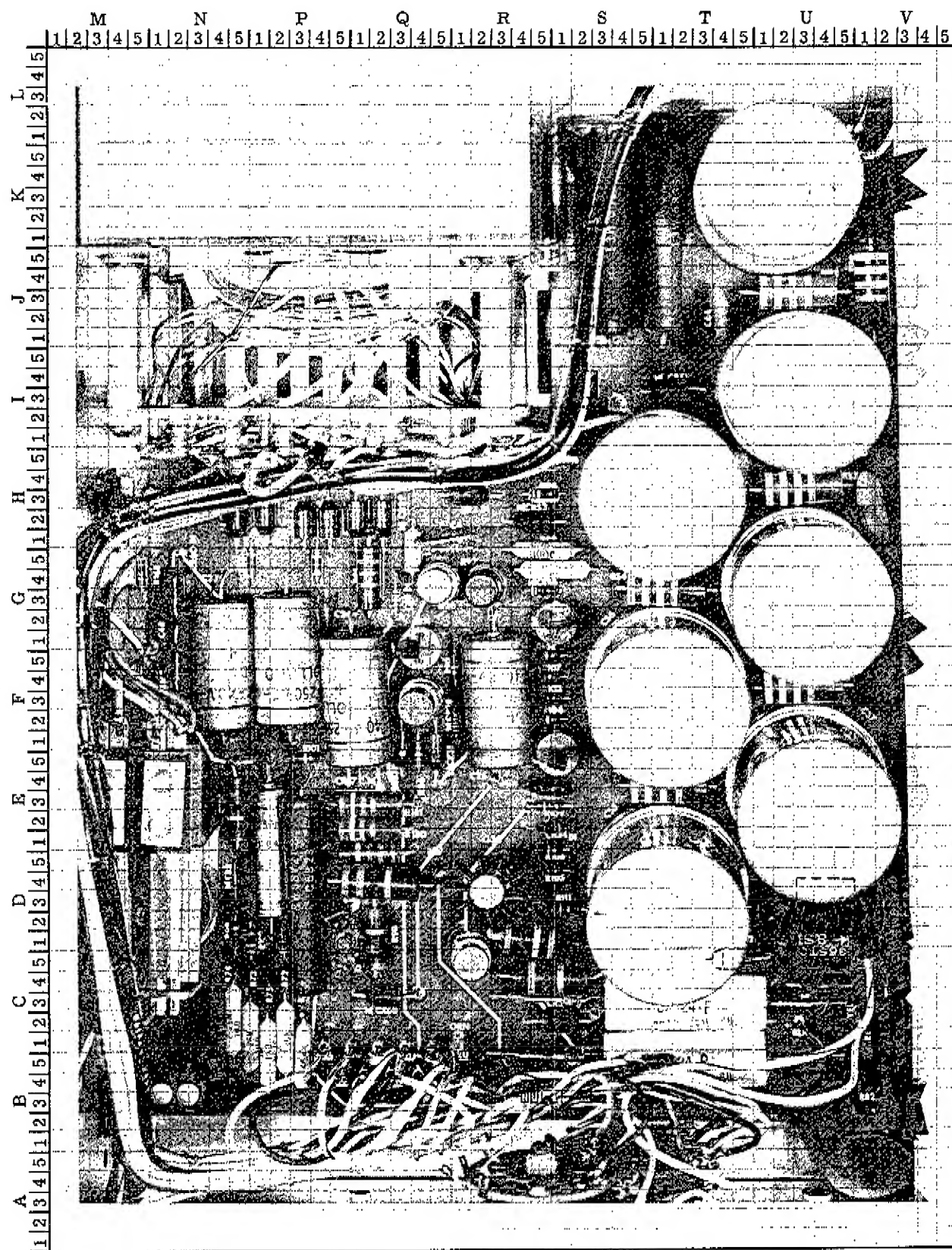


Figure 5-4. MAIN P/C ASSEMBLY (Left Hand Side)

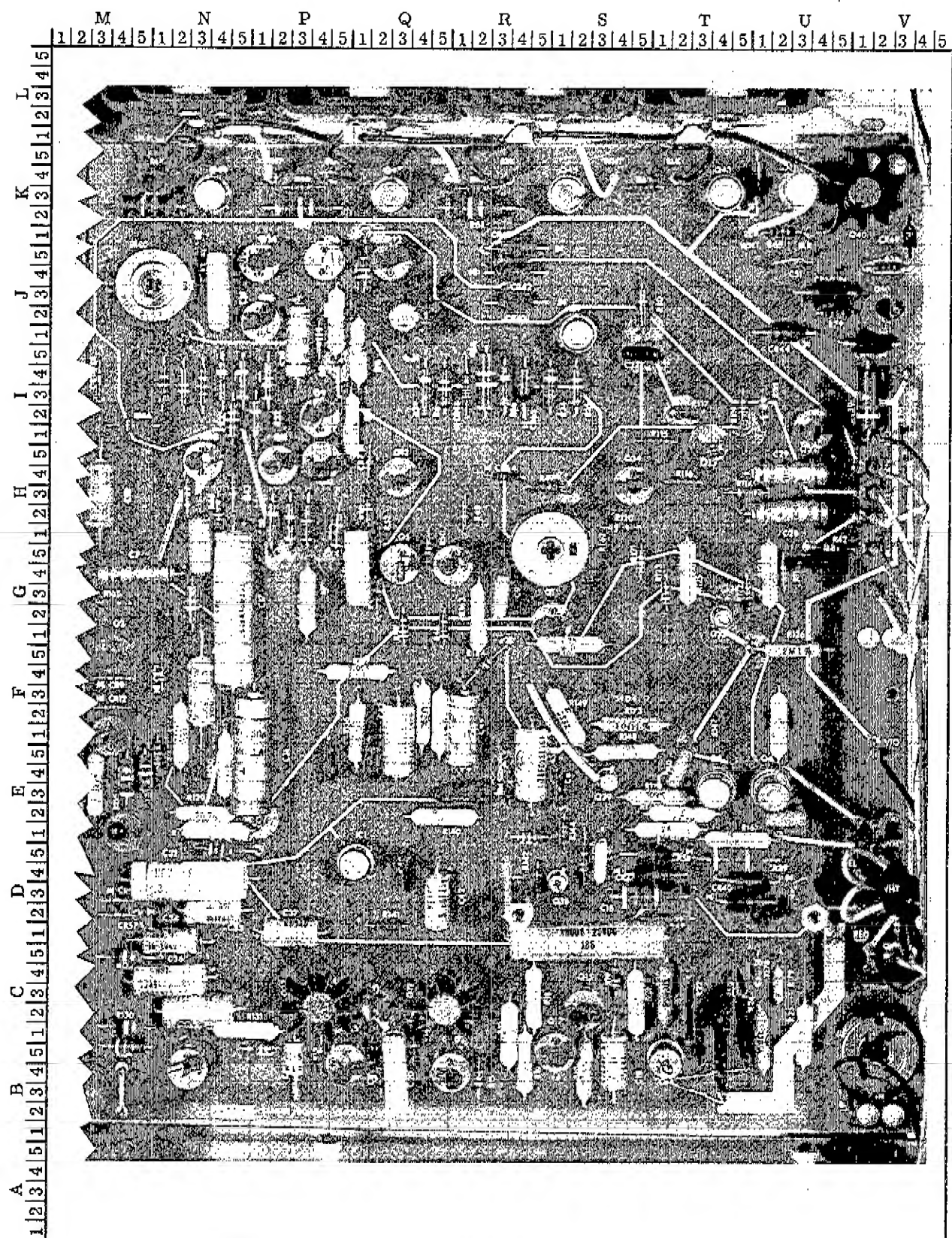



Figure 5-5. MAIN P/C ASSEMBLY (Right Hand Side)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| CR24 | H2-P3 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR25 | H2-P1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR26 | H2-Q1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR27 | H2-Q2 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR28 | F2-R1 | Diode, zener, 10v (Fig. 5-4) | 4809-246611 | 07910 | 1N961B | 2 | | |
| CR29 | G4-R2 | Diode, thyristor (Fig. 5-4) | 4837-192567 | 03508 | C-6F | 1 | 1 | |
| CR30 | F1-Q3 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR31 | F1-Q5 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR32 | C5-T5 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR33 | C4-U4 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR34 | E2-S1 | Diode, zener, 16v (Fig. 5-4) | 4809-113332 | 07910 | 1N966A | 1 | | |
| CR35 | C2-S1 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR37 | D4-T1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR38 | D5-T1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR39 | D4-U1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR40 | D3-U1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR41 | J5-R4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR42 | J4-R4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR43 | J3-R4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR44 | J1-U2 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR45 | J1-V1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR47 | K4-U1 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR48 | I3-R1 | Diode, zener, 13v (Fig. 5-5) | 4809-110726 | 07910 | 1N964B | 1 | 2 | |
| CR50 | J3-U4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR51 | I3-T1 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |





| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|----------------|--|----------------------------|----------------|----------------|------------|------------|-------------|
| CR52 | H2-R5 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR53 | D3-U4 | Diode, silicon, 350 ma, 3000 piv (Fig. 5-4) | 4801-246652 | 17545 | 35ST3 | 2 | 2 | |
| CR54 | D1-U4 | Diode, silicon, 350 ma, 3000 piv (Fig. 5-4) | 4801-246652 | 17545 | 35ST3 | REF | | |
| CR55 | G3-R5 | Diode, zener, 10v (Fig. 5-4) | 4809-246611 | 07910 | 1N961B | REF | | |
| CR56 | D3-M4 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR57 | D2-M4 | Diode, silicon, 150 ma (Fig. 5-5) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR59 | D1-V4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR60 | G4-N2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR61 | F5-N2 | Diode, silicon, 1 amp, 600 piv (Fig. 5-4) | 4802-112383 | 05277 | 1N4822 | REF | | |
| CR64 | H4-R3 | Diode, zener, 6.2v (Fig. 5-5) | 4809-180497 | 07910 | 1N753 | 1 | | |
| CR65 | I4-R4 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR66 | D1-P2 | Diode, zener, 10v (Fig. 5-4) | 4809-246611 | 07910 | 1N961B | REF | | |
| CR67 | E4-Q1 | Diode, silicon, 150 ma (Fig. 5-4) | 4805-203323 | 03508 | DHD1105 | REF | | |
| CR68 | C3-Q2 | Diode, silicon, 1 amp, 100 piv (Fig. 5-4) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR69 | K1-V3 | Diode, silicon, 1 amp, 100 piv (Fig. 5-5) | 4802-116111 | 05277 | 1N4817 | REF | | |
| CR70 | C1-T3 | Diode, silicon, 150 ma, 6 piv (Fig. 5-5) | 4805-113308 | 07910 | CD13161 | 1 | | |
| DS1 | D1-P5 | Lamp, neon (Figure 5-4) | 3902-100347 | 71744 | NE2E | 2 | | |
| DS2 | C5-P5 | Lamp, neon (Figure 5-4) | 3902-100347 | 71744 | NE2E | REF | | |
| IC1 | D5-Q1 | IC, operational amplifier (Fig. 5-5) | 3140-246603 | 04713 | MC1709CG | 1 | | |
| K1 | E1-N2 | Relay, dpdt, 115v, 15 amp (Fig. 5-4) | 4504-246678 | 73949 | 245U2C24D | 1 | | |
| K2 | C3-S2 C2-T2 | Relay (Fig. 5-4) Switch, dry reed Coil, reed switch, 24v | 5103-184440 1802-186155 | 12617 71707 | DRVT1 SP24P | 2 2 | | |
| K3 | B5-S2 B5-T2 | Relay (Fig. 5-4) Switch, dry reed Coil, reed switch, 24v | 5103-184440 1802-186155 | 12617 71701 | DRVT1 SP24P | REF REF | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|---|-------|----------------|------------|------------|-------------|
| L1 | G5-Q4 | Choke, RF, 1,000 uh, 140 ma (Fig. 5-4) | 1801-147819 | 72259 | WEE1000 | 1 | | |
| Q1 | G2-S1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | 14 | 3 | |
| Q2 | F5-M3 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q3 | F1-M3 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q4 | E3-U2 | Tstr, silicon, NPN (Fig. 5-5) | 4819-179374 | 04713 | 2N2218 | 2 | | |
| Q5 | G4-Q3 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | 10 | 3 | |
| Q6 | G4-R1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q7 | J1-S2 | Tstr, silicon, PNP (Fig. 5-5) | 4818-190389 | 04713 | SM4144 | 2 | | |
| Q8 | E3-T4 | Tstr, silicon, NPN (Fig. 5-5) | 4819-179374 | 04713 | 2N2218 | REF | | |
| Q9 | I2-P4 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q10 | H5-N3 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q11 | H5-P2 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q12 | H5-P4 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q13 | H4-Q3 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q14 | B5-T2 | Tstr, Factory matched (Fig. 5-5) |  | | | | | |
| Q15 | C2-S2 | Tstr, silicon, NPN (Fig. 5-5) | 4819-168708 | 03508 | 2N3391 | 2 | | |
| Q16 | J5-P4 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q17 | B5-S1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-168708 | 03508 | 2N3391 | REF | | |
| Q18 | J2-P1 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q19 | C2-Q5 | Tstr, silicon, NPN (Fig. 5-5) | 4819-203489 | 07910 | CDQ10656 | 4 | 2 | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|-------------|-------|----------------|------------|------------|-------------|
| Q20 | B4-R1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q21 | J2-Q3 | Tstr, silicon, PNP (Fig. 5-5) | 4818-190389 | 04713 | SM4144 | REF | | |
| Q22 | J5-Q2 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q23 | C2-P4 | Tstr, silicon, NPN (Fig. 5-5) | 4819-203489 | 07910 | CDQ10656 | REF | | |
| Q24 | J5-P1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q25 | B4-P5 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q26 | G4-Q5 | Tstr, silicon, NPN (Fig. 5-4) | 4819-150359 | 95303 | 2N3053 | 2 | 1 | |
| Q27 | F3-Q4 | Tstr, silicon, NPN (Fig. 5-4) | 4819-150359 | 95303 | 2N3053 | REF | | |
| Q28 | G2-S1 | Tstr, silicon, NPN (Fig. 5-4) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q29 | E5-S1 | Tstr, silicon, NPN (Fig. 5-4) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q30 | C5-R1 | Tstr, silicon, NPN (Fig. 5-4) | 4819-218511 | 95303 | 40327 | 6 | 4 | |
| Q31 | D3-R2 | Tstr, silicon, NPN (Fig. 5-4) | 4819-218511 | 95303 | 40327 | REF | | |
| Q32 | I1-U4 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q33 | I1-T4 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q34 | H4-S5 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q35 | G2-T4 | Tstr, Dual FET, N-channel (Fig. 5-5) | 4828-248005 | 05397 | 2N3958 | 1 | 1 | |
| Q36 | E1-M4 | Tstr, silicon, PNP (Fig. 5-5) | 4818-225599 | 07263 | S-22650 | 1 | | |
| Q37 | B4-N2 | Tstr, silicon, PNP (Fig. 5-5) | 4818-195974 | 04713 | 2N3906 | REF | | |
| Q38 | D4-S1 | Tstr, FET, N-channel (Fig. 5-5) | 4826-257121 | 07263 | FE0654C | 1 | 1 | |
| Q39 | E4-S4 | Tstr, MOS FET, P-channel (Fig. 5-5) | 4831-226043 | 07263 | FT704 | 1 | 1 | |

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| Q40 | K3-V1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-203489 | 07910 | CDQ10656 | REF | | |
| Q41 | K3-U3 | Tstr, silicon, NPN (Fig. 5-5) | 4819-203489 | 07910 | CDQ10656 | REF | | |
| Q43 | K3-T4 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218511 | 95303 | 40327 | REF | | |
| Q45 | K3-S1 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218511 | 95303 | 40327 | REF | | |
| Q47 | K3-Q2 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218511 | 95303 | 40327 | REF | | |
| Q49 | K3-N3 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218511 | 95303 | 40327 | REF | | |
| Q50 | J3-V2 | Tstr, silicon, NPN (Fig. 5-5) | 4819-218396 | 04713 | 2N3904 | REF | | |
| Q51 | G1-Q4 | Tstr, silicon, NPN (Fig. 5-4) | 4819-218396 | 04713 | 2N3904 | REF | | |
| R1 | G5-P4 | Res, comp, 10 Ω \pm 5%, 1/4w (Fig. 5-4) | 4704-147868 | 01121 | CB1005 | 2 | | |
| R2 | G5-P1 | Res, comp, 10 Ω \pm 5%, 1/4w (Fig. 5-4) | 4704-147868 | 01121 | CB1005 | REF | | |
| R3 | J4-Q1 | Res, comp, 390 Ω \pm 5%, 1/2w (Fig. 5-5) | 4704-109082 | 01121 | EB3915 | 1 | | |
| R4 | J5-N5 | Res, comp, 27k \pm 5%, 1/4w (Fig. 5-5) | 4704-148148 | 01121 | CB2735 | 2 | | |
| R5 | I4-N3 | Res, comp, 5.6k \pm 5%, 1/2w (Fig. 5-5) | 4704-187880 | 01121 | EB5625 | 1 | | |
| R6 | I4-N4 | Res, comp, 22 Ω \pm 5%, 1/2w (Fig. 5-5) | 4704-169847 | 01121 | EB2205 | 1 | | |
| R7 | I4-P1 | Res, comp, 75k \pm 5%, 1/2w (Fig. 5-5) | 4704-108928 | 01121 | EB7535 | 1 | | |
| R8 | I4-N5 | Res, comp, 7.5k \pm 5%, 1/2w (Fig. 5-5) | 4704-108910 | 01121 | EB7525 | 2 | | |
| R9 | J1-P4 | Res, comp, 33k \pm 5%, 1/4w (Fig. 5-5) | 4704-148155 | 01121 | CB3335 | 1 | | |
| R10 | J2-P5 | Res, met flm, 15k \pm 1%, 1/2w (Fig. 5-5) | 4705-151498 | 19701 | Type MF7C | 2 | | |
| R11 | I5-Q1 | Res, met flm, 15k \pm 1%, 1/2w (Fig. 5-5) | 4705-151498 | 19701 | Type MF7C | REF | | |
| R12 | B5-P4 | Res, comp, 2k \pm 5%, 1/4w (Fig. 5-5) | 4704-202879 | 01121 | CB2025 | 3 | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|--|-------|----------------|------------|------------|-------------|
| R13 | C1-R4 | Res, met flm, 75k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-193961 | 19701 | Type MF7C | 1 | | |
| R14 | C1-Q4 | Res, comp, 1.5 Ω $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-246793 | 01121 | EB15G5 | 1 | | |
| R15 | B4-R2 | Res, comp, 75k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-220525 | 01121 | CB7535 | 1 | | |
| R16 | B4-R5 | Res, met flm, 8.25k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-192492 | 19701 | Type MF7C | 1 | | |
| R17 | B4-S2 | Res, met flm, 57.6k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-246777 | 19701 | Type MF7C | 1 | | |
| R18 | C3-R5 | Res, met flm, 6.04k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-162586 | 19701 | Type MF7C | 1 | | |
| R19 | C4-S4 | Res, comp, 10k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148106 | 01121 | CB1035 | 3 | | |
| R20 | C3-T2 | Res, met flm, 2.74k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-240614 | 19701 | Type MF7C | 1 | | |
| R21 | C3-S5 | Res, met flm, factory matched (Fig. 5-5) |  | | | | | |
| R22 | C3-T3 | Res, ww, factory matched (Fig. 5-5) |  | | | | | |
| R23 | B5-T4 | Res, ww, factory matched (Fig. 5-5) |  | | | | | |
| R24 | C2-T5 | Res, factory matched (Fig. 5-5) |  | | | | | |
| R25 | C1-U3 | Res, met flm, 499 Ω $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151514 | 19701 | Type MF7C | 1 | | |
| R26 | C1-V2 | Res, var, ww, 100 Ω $\pm 20\%$, 1-1/4w (Fig. 5-5) | 4702-112797 | 71450 | Type 110 | 1 | | |
| R27 | C1-U1 | Res, met flm, 178 Ω $\pm 0.5\%$, 1/2w (Fig. 5-5) | 4705-256255 | 19701 | Type MF7C | 1 | | |
| R28 | D2-T2 | Res, comp, 2.7 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-246744 | 01121 | CB27G5 | 1 | | |
| R29 | H1-P5 | Res, comp, 8.2k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-147777 | 01121 | EB8225 | 2 | | |
| R30 | H2-Q1 | Res, comp, 10k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148106 | 01121 | CB1035 | REF | | |
| R31 | I2-Q1 | Res, met flm, 11k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-222216 | 19701 | Type MF7C | 2 | | |
| R32 | I2-P1 | Res, comp, 5.1k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-109108 | 01121 | EB5125 | 4 | | |

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R33 | I2-N5 | Res, comp, 16k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-159632 | 01121 | EB1635 | 1 | | |
| R34 | I4-S1 | Res, comp, 5.1k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-109108 | 01121 | EB5125 | REF | | |
| R35 | I4-S2 | Res, comp, 15k $\pm 10\%$, 1/2w (Fig. 5-5) | 4704-108530 | 01121 | EB1531 | 1 | | |
| R36 | H1-P3 | Res, comp, 75 Ω $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-108753 | 01121 | EB7505 | 2 | | |
| R37 | H1-P3 | Res, comp, 75 Ω $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-108753 | 01121 | EB7505 | REF | | |
| R38 | G3-P3 | Res, met flm, 11k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-222216 | 19701 | Type MF7C | REF | | |
| R39 | I3-Q4 | Res, comp, 5.1k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-109108 | 01121 | EB5125 | REF | | |
| R40 | H1-P2 | Res, comp, 5.1k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-109108 | 01121 | EB5125 | REF | | |
| R42 | G5-U5 | Res, met flm, 34.8k $\pm 1\%$, 1/8w (Fig. 5-5) | 4705-261487 | 19701 | Type MF5C | 1 | | |
| R43 | H3-N5 | Res, comp, 5.1k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-193342 | 01121 | CB5125 | 2 | | |
| R44 | H2-N4 | Res, comp, 3.9k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148064 | 01121 | CB3925 | 1 | | |
| R45 | H3-N2 | Res, comp, 8.2 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-246751 | 01121 | CB82G5 | 1 | | |
| R46 | G1-Q5 | Res, comp, 8.2k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-160796 | 01121 | CB8225 | 2 | | |
| R47 | G1-Q3 | Res, comp, 4.7k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148072 | 01121 | CB4725 | 1 | | |
| R48 | H2-R1 | Res, comp, 5.1k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-193342 | 01121 | CB5125 | REF | | |
| R49 | H4-R5 | Res, comp, 2k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-202879 | 01121 | CB2025 | REF | | |
| R50 | G5-Q4 | Res, comp, 27k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148148 | 01121 | CB2735 | REF | | |
| R51 | G3-Q2 | Res, comp, 20 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-246728 | 01121 | CB2005 | 1 | | |
| R52 | H1-Q2 | Res, comp, 2k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-202879 | 01121 | CB2025 | REF | | |
| R53 | H3-U2 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | 6 | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R54 | G3-S5 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | REF | | |
| R55 | D3-V2 | Res, ww, 1k $\pm 5\%$, 5w (Fig. 5-4) | 4706-246835 | 91637 | Type CW10 | 2 | | |
| R56 | F3-U2 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | REF | | |
| R57 | E3-S5 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | REF | | |
| R58 | K3-M5 | Res, comp, 150k $\pm 5\%$, 1w (Fig. 5-5) | 4704-153122 | 01121 | GB1545 | 4 | | |
| R59 | K4-P3 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | 6 | | |
| R60 | K3-P3 | Res, comp, 150k $\pm 5\%$, 1w (Fig. 5-5) | 4704-153122 | 01121 | GB1545 | REF | | |
| R61 | K3-R1 | Res, comp, 150k $\pm 5\%$, 1w (Fig. 5-5) | 4704-153122 | 01121 | GB1545 | REF | | |
| R62 | K4-R2 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | REF | | |
| R63 | K4-S5 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | REF | | |
| R64 | I4-R2 | Res, comp, 150k $\pm 5\%$, 1w (Fig. 5-5) | 4704-153122 | 01121 | GB1545 | REF | | |
| R65 | K1-U2 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | REF | | |
| R66 | I4-R3 | Res, comp, 7.5k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-108910 | 01121 | EB7525 | REF | | |
| R67 | K5-U3 | Res, comp, 6.8k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148098 | 01121 | CB6825 | 1 | | |
| R68 | I4-Q5 | Res, comp, 150k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-150177 | 01121 | EB1545 | 1 | | |
| R70 | I2-V3 | Res, met flm, 56.2 Ω $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-150938 | 19701 | Type MF7C | 1 | | |
| R71 | C1-P3 | Res, met flm, 46.4k $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-247767 | 19701 | Type MF7C | 1 | 1 | |
| R72 | C1-P2 | Res, met flm, 536k $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-233874 | 19701 | Type MF7C | 1 | | |
| R73 | C2-P1 | Res, met flm, 2.26M $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-221564 | 19701 | Type MF7C | 2 | | |
| R74 | C3-N5 | Res, met flm, 2.26M $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-221564 | 19701 | Type MF7C | REF | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R75 | B5-P1 | Res, met flm, 1M $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-161075 | 19701 | Type MF7C | 1 | | |
| R78 | J5-V2 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | REF | | |
| R79 | J2-U5 | Res, comp, 620 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221903 | 01121 | CB6215 | REF | | |
| R80 | J3-S5 | Res, comp, 2k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-169854 | 01121 | EB2025 | 1 | | |
| R81 | C1-V2 | Res, ww, 1k $\pm 5\%$, 5w (Fig. 5-4) | 4706-246835 | 91637 | Type CW5 | REF | | |
| R82 | B3-V1 | Res, comp, 750 Ω $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-218024 | 01121 | CB7515 | 2 | | |
| R83 | B3-R5 | Res, comp, 750 Ω $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-218024 | 01121 | CB7515 | REF | | |
| R84 | D3-P3 | Res, ww, 2k $\pm 5\%$, 10w (Fig. 5-4) | 4706-246843 | 91637 | Type CW10 | 1 | | |
| R85 | G4-Q1 | Res, comp, 5.1 Ω $\pm 5\%$, 1w (Fig. 5-4) | 4704-219071 | 01121 | GB51G5 | 1 | | |
| R86 | E5-Q4 | Res, comp, 12k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-159731 | 01121 | CB1235 | 1 | | |
| R87 | D5-Q1 | Res, comp, 2.2k $\pm 10\%$, 1w (Fig. 5-4) | 4704-109843 | 01121 | GB2221 | 1 | | |
| R88 | H1-R5 | Res, met flm, 169k $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-176206 | 19701 | Type MF7C | 2 | | |
| R89 | G4-R5 | Res, met flm, 9.09k $\pm 1\%$, 1/2w (Fig. 5-4) | 4705-151258 | 19701 | Type MF7C | 2 | | |
| R90 | F5-R1 | Res, comp, 15k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148114 | 01121 | CB1535 | 4 | | |
| R91 | D4-Q1 | Res, comp, 1.8k $\pm 10\%$, 2w (Fig. 5-4) | 4704-185983 | 01121 | HB1821 | 1 | | |
| R92 | H1-Q5 | Res, comp, 18k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148122 | 01121 | CB1835 | 2 | | |
| R93 | J3-U3 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | REF | | |
| R94 | J4-V1 | Res, comp, 390k $\pm 10\%$, 2w (Fig. 5-4) | 4704-246801 | 01121 | HB3941 | REF | | |
| R95 | H3-R5 | Res, comp, 33 Ω $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-175034 | 01121 | CB3305 | 1 | | |
| R96 | K1-S4 | Res, ww, 200k $\pm 5\%$, 10w (Fig. 5-4) | 4706-246850 | 91637 | Type CW10 | 2 | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R97 | K1-T1 | Res, ww, 200k $\pm 5\%$, 10w (Fig. 5-4) | 4706-246850 | 91637 | Type CW10 | REF | | |
| R98 | D1-Q2 | Res, comp, 1M $\pm 10\%$, 1w (Fig. 5-4) | 4704-109793 | 01121 | GB1051 | 1 | | |
| R99 | D1-N5 | Res, comp, 820 Ω $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148015 | 01121 | CB8215 | 1 | | |
| R100 | E2-N5 | Res, comp, 51 Ω $\pm 5\%$, 1w (Fig. 5-4) | 4704-157586 | 01121 | GB5105 | 1 | | |
| R101 | E5-P3 | Res, comp, 15k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148114 | 01121 | CB1535 | REF | | |
| R102 | D1-P1 | Res, comp, 3.3k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148056 | 01121 | CB3325 | 1 | | |
| R103 | F3-R5 | Res, comp, 1k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148023 | 01121 | CB1025 | 1 | | |
| R104 | F2-R5 | Res, comp, 10k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148106 | 01121 | CB1035 | REF | | |
| R105 | D5-R5 | Res, comp, 2.7k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-170720 | 01121 | CB2725 | 2 | | |
| R106 | E1-R5 | Res, comp, 15k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148114 | 01121 | CB1535 | REF | | |
| R107 | F4-R5 | Res, comp, 8.2k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-160796 | 01121 | CB8225 | REF | | |
| R108 | F5-R5 | Res, comp, 22k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-148130 | 01121 | CB2235 | 3 | | |
| R109 | E3-R5 | Res, comp, 2.7k $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-170720 | 01121 | CB2725 | REF | | |
| R110 | C4-R5 | Res, comp, 5.6k $\pm 5\%$, 2w (Fig. 5-4) | 4704-218842 | 01121 | HB5625 | 1 | | |
| R111 | D3-S1 | Res, comp, 62k $\pm 5\%$, 1/2w (Fig. 5-4) | 4704-108522 | 01121 | EB6235 | 1 | | |
| R112 | D1-R5 | Res, comp, 15k $\pm 10\%$, 2w (Fig. 5-4) | 4704-110080 | 01121 | HB1531 | 1 | | |
| R113 | G4-U2 | Res, comp, 510 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-218032 | 01121 | CB5115 | 1 | | |
| R114 | H3-T5 | Res, comp, 6.2k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221911 | 01121 | CB6225 | 1 | | |
| R115 | I1-T1 | Res, comp, 560 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-147991 | 01121 | CB5615 | 2 | | |
| R116 | H4-T2 | Res, comp, 560 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-147991 | 01121 | CB5615 | REF | | |

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R117 | I2-T3 | Res, comp, 680 Ω \pm 5%, 1/4w (Fig. 5-5) | 4704-148007 | 01121 | CB6815 | 1 | | |
| R118 | I3-U1 | Res, comp, 30k \pm 5%, 1/4w (Fig. 5-5) | 4704-193417 | 01121 | CB3035 | 1 | | |
| R119 | I3-T5 | Res, comp, 11k \pm 5%, 1/4w (Fig. 5-5) | 4704-221580 | 01121 | CB1135 | 1 | | |
| R120 | H1-S4 | Res, comp, 1.3k \pm 5%, 1/4w (Fig. 5-5) | 4704-234252 | 01121 | CB1325 | 1 | | |
| R121 | G5-S5 | Res, comp, 18k \pm 5%, 1/4w (Fig. 5-5) | 4704-148122 | 01121 | CB1835 | REF | | |
| R122 | G3-T5 | Res, comp, 180 Ω \pm 5%, 1/4w (Fig. 5-5) | 4704-147942 | 01121 | CB1815 | 2 | | |
| R123 | G3-T1 | Res, comp, 180 Ω \pm 5%, 1/4w (Fig. 5-5) | 4704-147942 | 01121 | CB1815 | REF | | |
| R124 | G4-U1 | Res, met flm, 20k \pm 1%, 1/2w (Fig. 5-5) | 4705-162438 | 19701 | Type MF7C | 2 | | |
| R125 | G4-T2 | Res, met flm, 20k \pm 1%, 1/2w (Fig. 5-5) | 4705-162438 | 19701 | Type MF7C | REF | | |
| R126 | F5-U3 | Res, met flm, 2M \pm 1%, 1/2w (Fig. 5-5) | 4705-217760 | 19701 | Type MF7C | 1 | | |
| R127 | D5-N4 | Res, comp, 36k \pm 5%, 1/2w (Fig. 5-5) | 4704-185991 | 01121 | EB3635 | 1 | | |
| R128 | E1-N4 | Res, met flm, 34k \pm 1%, 1/2w (Fig. 5-5) | 4705-151241 | 19701 | Type MF7C | 3 | | |
| R129 | E2-N4 | Res, met flm, 28.7k \pm 1%, 1/2w (Fig. 5-5) | 4705-193987 | 19701 | Type MF7C | 1 | | |
| R130 | C1-M4 | Res, comp, 100k \pm 5%, 1/2w (Fig. 5-5) | 4704-168054 | 01121 | EB1045 | 1 | | |
| R131 | C1-P1 | Res, met flm, 10k \pm 1%, 1/2w (Fig. 5-5) | 4705-151274 | 19701 | Type MF7C | 3 | | |
| R132 | C5-M4 | Res, comp, 100k \pm 5%, 1/2w (Fig. 5-5) | 4704-168054 | 01121 | EB1045 | 1 | | |
| R133 | E4-N4 | Res, met flm, 10k \pm 1%, 1/2w (Fig. 5-5) | 4705-151274 | 19701 | Type MF7C | REF | | |
| R134 | B5-M4 | Res, comp, 24k \pm 5%, 1/2w (Fig. 5-5) | 4704-108654 | 01121 | EB2435 | 1 | | |
| R135 | B5-P1 | Res, comp, 62k \pm 5%, 1/4w (Fig. 5-5) | 4704-220053 | 01121 | CB6235 | 1 | | |
| R136 | F1-Q1 | Res, met flm, 68.1k \pm 1%, 1/2w (Fig. 5-5) | 4705-161083 | 19701 | Type MF7C | 1 | | |

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|-------------|-------|----------------|------------|------------|-------------|
| R137 | F4-Q1 | Res, met flm, 8.06k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-159467 | 19701 | Type MF7C | 1 | | |
| R138 | F2-Q5 | Res, met flm, 34k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151241 | 19701 | Type MF7C | REF | | |
| R139 | F3-Q4 | Res, met flm, 162 Ω $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151175 | 19701 | Type MF7C | 1 | | |
| R140 | E2-Q5 | Res, met flm, 34k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151241 | 19701 | Type MF7C | REF | | |
| R141 | D1-Q3 | Res, comp, 1.5k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148031 | 01121 | CB1525 | 1 | | |
| R142 | D4-R5 | Res, comp, 220 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-147959 | 01121 | CB2215 | 1 | | |
| R143 | E1-R5 | Res, comp, 13k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-221598 | 01121 | CB1335 | 1 | | |
| R144 | E1-S1 | Res, comp, 200 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-193482 | 01121 | CB2015 | 3 | | |
| R145 | E4-R4 | Res, comp, 22k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148130 | 01121 | CB2235 | REF | | |
| R146 | D5-S2 | Res, comp, 3.3M $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-208389 | 01121 | CB3355 | 1 | | |
| R147 | F2-U2 | Res, met flm, 9.09k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151258 | 19701 | Type MF7C | REF | | |
| R148 | E5-S4 | Res, met flm, 249k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-218685 | 19701 | Type MF7C | 1 | | |
| R149 | F3-S1 | Res, met flm, 383k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-176388 | 19701 | Type MF7C | 1 | | |
| R150 | E4-M4 | Res, comp, 47k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-108738 | 01121 | EB4735 | 1 | | |
| R151 | E4-M5 | Res, comp, 180k $\pm 10\%$, 1/2w (Fig. 5-5) | 4704-108431 | 01121 | EB1841 | 1 | | |
| R152 | E5-N1 | Res, comp, 22k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148130 | 01121 | CB2235 | REF | | |
| R153 | G3-N3 | Res, comp, 22k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-186064 | 01121 | EB2235 | 3 | | |
| R154 | F1-N2 | Res, met flm, 253k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-247452 | 19701 | Type MF7C | 2 | | |
| R155 | E3-M3 | Res, met flm, 243k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-247452 | 19701 | Type MF7C | REF | | |
| R156 | I2-M5 | Res, comp, 22k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-186064 | 01121 | EB2235 | REF | | |

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R157 | I3-N2 | Res, comp, 22k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-186064 | 01121 | EB2235 | REF | | |
| R158 | I3-N1 | Res, comp, 8.2k $\pm 5\%$, 1/2w (Fig. 5-5) | 4704-147777 | 01121 | EB8225 | REF | | |
| R159 | J3-M3 | Res, comp, 15k $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-148114 | 01121 | CB1535 | REF | | |
| R160 | J4-M5 | Res, var, ww, 10k $\pm 20\%$, 1-1/4w (Fig. 5-5) | 4702-112862 | 71450 | Type 110 | 1 | | |
| R161 | G1-S2 | Res, met flm, 24.3k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-217430 | 19701 | Type MF7C | 1 | | |
| R162 | H1-S1 | Res, var, ww, 5k $\pm 5\%$, 2w (Fig. 5-5) | 4702-111609 | 71450 | Type E115 | 1 | | |
| R163 | G2-R2 | Res, met flm, 4.22k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-223396 | 19701 | Type MF7C | 1 | | |
| R164 | F4-R2 | Res, comp, 10M $\pm 10\%$, 1/2w (Fig. 5-5) | 4704-108142 | 01121 | EB1061 | 1 | | |
| R165 | G3-M4 | Res, comp, 200 Ω $\pm 5\%$, 1/4w (Fig. 5-5) | 4704-193482 | 01121 | CB2015 | REF | | |
| R166 | D5-T5 | Res, comp, 470 Ω $\pm 10\%$, 1w (Fig. 5-5) | 4704-109710 | 01121 | GB4711 | 2 | | |
| R167 | E1-T5 | Res, met flm, 10k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151274 | 19701 | Type MF7C | REF | | |
| R168 | G4-M5 | Res, comp, 200 Ω $\pm 5\%$, 1/4w (Fig. 5-4) | 4704-193482 | 01121 | CB2015 | REF | | |
| R169 | F2-M5 | Res, comp, 56 Ω $\pm 10\%$, 2w (Fig. 5-4) | 4704-110221 | 01121 | HB5601 | 1 | | |
| R170 | E3-T1 | Res, met flm, 169k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-176206 | 19701 | Type MF7C | REF | | |
| R171 | E2-T2 | Res, met flm, 51.1k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-159665 | 19701 | Type MF7C | 1 | | |
| R172 | E1-T2 | Res, met flm, 2k $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151266 | 19701 | Type MF7C | 1 | | |
| R173 | F2-S5 | Res, met flm, 10 Ω $\pm 1\%$, 1/2w (Fig. 5-5) | 4705-151043 | 19701 | Type MF7C | 1 | | |
| R174 | D3-S5 | Res, comp, 470 Ω $\pm 10\%$, 1w (Fig. 5-5) | 4704-109710 | 01121 | GB4711 | REF | | |
| R178 | C4-U2 | Res, met flm, 2.1k $\pm 1\%$, 1/8w (Fig. 5-5) | 4705-168237 | 19701 | Type MF5C | 1 | | |
| R179 | C4-U1 | Res, met flm, 4.02k $\pm 1\%$, 1/8w (Fig. 5-5) | 4705-235325 | 19701 | Type MF5C | 1 | | |














| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| R180 | E2-Q1 | Res, comp, 240 Ω \pm 5%, 1w (Fig. 5-4) | 4704-190587 | 01121 | GB2415 | 3 | | |
| R181 | E3-Q1 | Res, comp, 240 Ω \pm 5%, 1w (Fig. 5-4) | 4704-190587 | 01121 | GB2415 | REF | | |
| R239 | I3-V1 | Res, comp, 240 Ω \pm 5%, 1w (Fig. 5-5) | 4704-190587 | 01121 | GB2415 | REF | | |
| | | Cover, thermal (not illustrated) | 3155-240390 | 89536 | 3155-240390 | 1 | | |
| | C2-R2 | Heat sink, transistor | 4841-104646 | 05820 | NF207 | 5 | | |



Q14, R21 and R24 are a factory selected and matched Reference Amplifier set. For Model 341A, replace the entire set, part number 4842-264044. For Model 343A, replace the entire set, part number 4842-264051.



R22 and R23 are a factory matched set. For replacement in the Model 341A, order part number 4707-265116. For replacement in the Model 343A, order part number 4707-265348.

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|---|-------|----------------|------------|------------|-------------|
| A4 | | REFERENCE P/C ASSEMBLY Figure 5-6 NOTE: The Reference P/C Assembly (A4), the Sample String P/C Assembly (A5) and their intermatched resistors can be ordered under one part number, 3158-252312. | 3158-240101 | 89536 | 3158-240101 | REF | | |
| C1 | C2-R4 | Cap, plstc, 0.1 uf $\pm 10\%$, 1, 200v | 1507-233718 | 84411 | JF 15 | 2 | | |
| C2 | C2-Q5 | Cap, plstc, 0.1 uf $\pm 10\%$, 1, 200v | 1507-233718 | 84411 | JF 15 | REF | | |
| R1 | F3-T1 | Res, var, ww, 1k $\pm 20\%$, 1-1/4w | 4702-113266 | 71450 | Type 110 | 1 | | |
| R2 | F3-Q5 | Res, ww, 1.4995M, matched |  | | | | | |
| R3 | G2-R5 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | 7 | | |
| R4 | G1-Q5 | Res, ww, 149.95k, matched |  | | | | | |
| R5 | E4-S1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |
| R6 | E3-Q5 | Res, met flm, 100 Ω $\pm 0.5\%$, 1/2w | 4705-256248 | 19701 | Type MF7C | 1 | | |
| R7 | E1-Q5 | Res, met flm, 200 Ω $\pm 1\%$, 1/2w | 4705-151480 | 19701 | Type MF7C | 1 | | |
| R8 | E5-Q5 | Res, ww, 14.9286k, matched |  | | | | | |
| R9 | K1-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R10 | K1-R5 | Res, ww, 99.975k, matched |  | | | | | |
| R11 | K1-T1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |
| R12 | J1-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R13 | J3-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R14 | J2-S1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |
| R15 | I3-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R16 | I3-R5 | Res, ww, 99.975k, matched |  | | | | | |
| R17 | I3-T1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |
| R18 | H3-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R19 | H5-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R20 | H5-S1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |
| R21 | G5-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R22 | H1-S1 | Res, ww, 99.975k, matched |  | | | | | |
| R23 | H1-T1 | Res, var, ww, 100 Ω $\pm 10\%$, 1-1/4w | 4702-208785 | 71450 | Type 110 | REF | | |

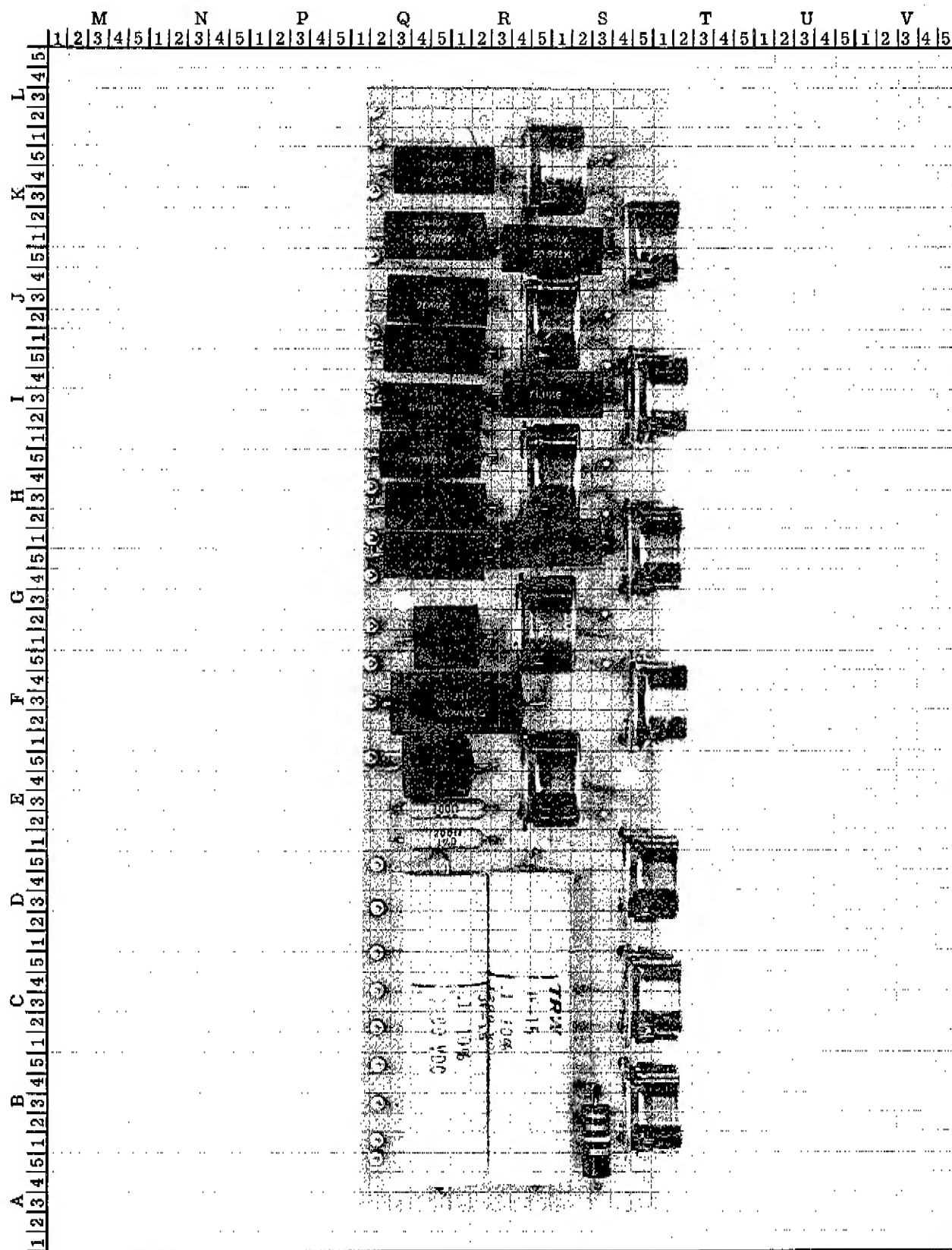















Figure 5-6. REFERENCE P/C ASSEMBLY (341A)

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|---|-------|----------------|------------|------------|-------------|
| R24 | B3-T1 | Res, var, ww, 10k $\pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | 3 | | |
| R25 | C3-T1 | Res, var, ww, 10k $\pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | REF | | |
| R26 | D4-T1 | Res, var, ww, 10k $\pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | REF | | |
| R27 | K4-Q5 | Res, ww, 99.975k, matched |  | | | | | |
| R28 | K4-S1 | Res, var, ww, 50 Ω $\pm 10\%$, 1-1/4w | 4702-144782 | 71450 | Type 110 | 1 | | |
| R29 | B1-S3 | Res, comp, 330k $\pm 5\%$, 1w | 4704-109777 | 01121 | GB3345 | 1 | | |



R2, R4, R8, R9/R10, R12/R13, R15/R16, R18/R19, R21/R22, R27 and A5R1 through A5R12 are an intermatched resistor set, part number 4710-252445. The resistors may be replaced individually by giving model, serial number, full reference designation, and all markings on the old resistor. However, R9/R10, R12/R13, R15/R16, R18/R19 and R21/R22 must be ordered and replaced in pairs.

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|--|-------|----------------|------------|------------|-------------|
| A5 | | SAMPLE STRING P/C ASSEMBLY Figure 5-7 NOTE: The Reference P/C Assembly, (A4), the Sample String P/C Assembly (A5) and their intermatched resistors can be ordered under one part number, 3158-252312. | 3158-263012 | 89536 | 3158-263012 | REF | | |
| CR1 | B3-T2 | Diode, silicon, 200 ma, 25 piv | 4805-190272 | 93332 | 1N456A | 2 | | |
| CR2 | A5-T2 | Diode, silicon, 200 ma, 25 piv | 4805-190272 | 93332 | 1N456A | REF | | |
| R1 | E2-Q4 | Res, ww, 10k, matched |  | | | | | |
| R2 | B4-Q2 | Res, ww, 20k, matched |  | | | | | |
| R3 | C2-Q4 | Res, ww, 20k, matched |  | | | | | |
| R4 | C5-Q4 | Res, ww, 20k, matched |  | | | | | |
| R5 | D2-Q4 | Res, ww, 20k, matched |  | | | | | |
| R6 | D4-Q4 | Res, ww, 20k, matched |  | | | | | |
| R7 | E5-Q4 | Res, ww, 1k, matched |  | | | | | |
| R8 | E1-Q4 | Res, ww, 2k, matched |  | | | | | |
| R9 | E4-Q4 | Res, ww, 2k, matched |  | | | | | |
| R10 | F1-Q4 | Res, ww, 2k, matched |  | | | | | |
| R11 | F3-Q4 | Res, ww, 2k, matched |  | | | | | |
| R12 | F3-Q4 | Res, ww, 2k, matched |  | | | | | |
| R13 | H4-Q4 | Res, ww, 100Ω ±0.03%, 1/2w | 4707-155846 | 89536 | 4707-155846 | 1 | | |
| R14 | G1-Q4 | Res, ww, 200Ω ±0.01%, 1/2w | 4707-178988 | 89536 | 4707-178988 | 5 | | |
| R15 | G3-Q4 | Res, ww, 200Ω ±0.01%, 1/2w | 4707-178988 | 89536 | 4707-178988 | REF | | |
| R16 | G5-Q4 | Res, ww, 200Ω ±0.01%, 1/2w | 4707-178988 | 89536 | 4707-178988 | REF | | |
| R17 | H1-Q4 | Res, ww, 200Ω ±0.01%, 1/2w | 4707-178988 | 89536 | 4707-178988 | REF | | |
| R18 | H3-Q4 | Res, ww, 200Ω ±0.01%, 1/2w | 4707-178988 | 89536 | 4707-178988 | REF | | |
| R19 | J3-Q5 | Res, ww, 10Ω ±0.5%, 0.7w | 4707-248732 | 01686 | Type T2 | 1 | | |
| R20 | H5-Q5 | Res, ww, 20Ω ±0.5%, 0.7w | 4707-248724 | 01686 | Type T2 | 5 | | |
| R21 | I2-Q5 | Res, ww, 20Ω ±0.5%, 0.7w | 4707-248724 | 01686 | Type T2 | REF | | |
| R22 | I4-Q5 | Res, ww, 20Ω ±0.5%, 0.7w | 4707-248724 | 01686 | Type T2 | REF | | |
| R23 | I5-Q5 | Res, ww, 20Ω ±0.5%, 0.7w | 4707-248724 | 01686 | Type T2 | REF | | |

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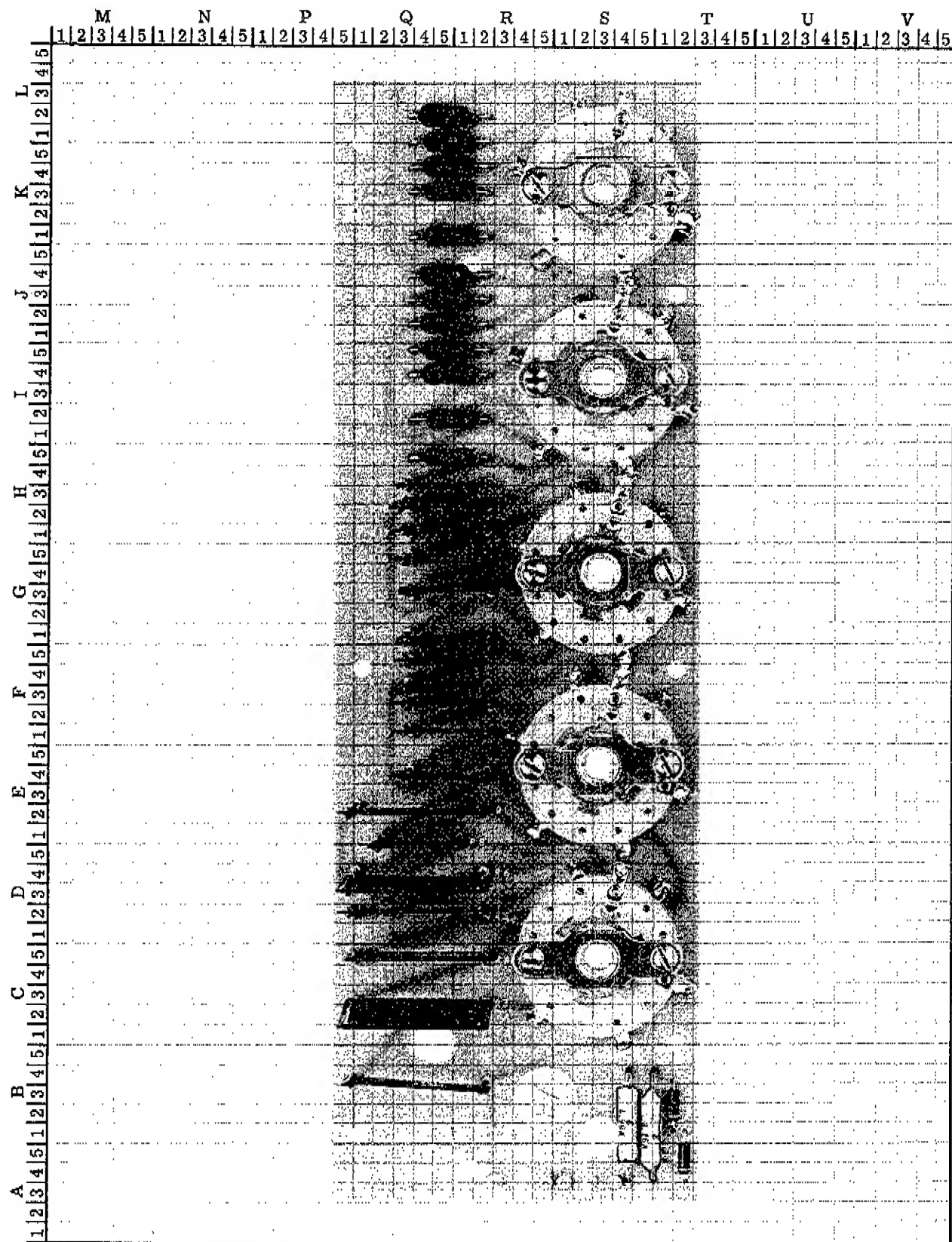



Figure 5-7. SAMPLE STRING P/C ASSEMBLY (341A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--------------------------------------|-------------|-------|----------------|------------|------------|-------------|
| R24 | J2-Q5 | Res, ww, $20\Omega \pm 0.5\%$, 0.7w | 4707-248724 | 01686 | Type T2 | REF | | |
| R25 | L2-Q5 | Res, ww, $1\Omega \pm 3\%$, 0.7w | 4707-248757 | 01686 | Type T2 | 1 | | |
| R26 | J4-Q5 | Res, ww, $2\Omega \pm 3\%$, 0.7w | 4707-248740 | 01686 | Type T2 | 5 | | |
| R27 | K1-Q5 | Res, ww, $2\Omega \pm 3\%$, 0.7w | 4707-248740 | 01686 | Type T2 | REF | | |
| R28 | K3-Q5 | Res, ww, $2\Omega \pm 3\%$, 0.7w | 4707-248740 | 01686 | Type T2 | REF | | |
| R29 | K5-Q5 | Res, ww, $2\Omega \pm 3\%$, 0.7w | 4707-248740 | 01686 | Type T2 | REF | | |
| R30 | L1-Q5 | Res, ww, $2\Omega \pm 3\%$, 0.7w | 4707-248740 | 01686 | Type T2 | REF | | |
| R31 | B1-T1 | Res, met flm, $3.16k \pm 1\%$, 1/2w | 4705-187781 | 19701 | Type MF7C | 1 | | |
| R32 | B2-S4 | Res, met flm, $4.99k \pm 1\%$, 1/2w | 4705-148890 | 19701 | Type MF7C | 1 | | |
| S2 | D1-S2 | Switch, rotary, Decade 2 | 5105-257253 | 89536 | 5105-257253 | 5 | | |
| S3 | F1-S2 | Switch, rotary, Decade 3 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S4 | H1-S2 | Switch, rotary, Decade 4 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S5 | I5-S2 | Switch, rotary, Decade 5 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S6 | K5-S2 | Switch, rotary, Decade 6 | 5105-257253 | 89536 | 5105-257253 | REF | | |



R1 Thru R12 are part of an intermatched resistor set, part number 4710-252445 (See , p. 5-30). The resistors may be replaced individually by giving model, serial number, full reference designation, and all markings on the old resistor, when ordering.

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|----------------------------|----------------|----------------------------|------------|------------|-------------|
| | | DC VOLTAGE CALIBRATOR Figure 5-8 | 343A | | | | | |
| A1 | | Front Panel Assembly (See Figure 5-9) | | | | | | |
| A2 | | Rear Panel Assembly (See Figure 5-10) | | | | | | |
| A3 | | Main P/C Assembly (See Figures 5-4 & 5-5) | 1702-265322 | 89536 | 1702-265322 | 1 | | |
| A4 | | Reference P/C Assembly (See Figure 5-11) | 3158-252437 | 89536 | 3158-252437 | 1 | | |
| A5 | | Sample String P/C Assembly (See Figure 5-12) | 3158-252429 | 89536 | 3158-252429 | 1 | | |
| C49 | | Cap, oil, 1 uf \pm 10%, 1500v | 1505-247023 | 56289 | 264P70 | 1 | | |
| C62 | | Cap, cer, 1 uf, gm, 3v | 1501-106567 | 14655 | HCC3105P | 3 | | |
| CR58 | | Diode, silicon, 1 amp, 100 piv | 4802-116111 | 05277 | 1N4817 | 25 | | |
| M1 | | Meter, 0-1.0v, 0-30 ma | 2901-246942 | 89536 | 2901-246942 | 1 | | |
| R41 | | Res, var, comp, 5k \pm 10%, 3w | 4701-247031 | 71450 | 321S502A | 1 | | |
| R177 | | Res, comp, 1 Ω \pm 5%, 1/2 w | 4704-218693 | 01121 | EB10G5 | 1 | | |
| S1 | | Switch, rotary, Decade 1 Switch section, decks A & B Switch section, decks C & D | 5105-257238 5105-257246 | 89536 89536 | 5105-257238 5105-257246 | 1 1 | | |
| S8 | | Switch, rotary, FUNCTION | 5105-257261 | 89536 | 5105-257261 | 1 | | |
| S9 | | Switch, rotary, RANGE Switch section, decks A & B Switch section, decks C & D | 5105-257212 5105-257220 | 89536 89536 | 5105-257212 5105-257220 | 1 1 | | |
| T1 | | Transformer, power | 5602-240465 | 89536 | 5602-240465 | 1 | | |
| 20 | | Bail, tilt-down (not illustrated) | 3154-231407 | 89536 | 3154-231407 | 1 | | |
| 21 | | Cover, bottom (not illustrated) | 3156-240382 | 89536 | 3156-240382 | 1 | | |
| 22 | | Cover, top (not illustrated) | 3156-240374 | 89536 | 3156-240374 | 1 | | |
| 23 | | Detent, switch, S1 | 5105-257287 | 89536 | 5105-257287 | 1 | | |
| 24 | | Detent, switch, S2 thru S7 | 5105-257295 | 89536 | 5105-257295 | 1 | | |
| 25 | | Detent, switch, S9 | 5105-257279 | 89536 | 5105-257279 | 1 | | |
| 26 | | Foot (not illustrated) | 3155-230037 | 89536 | 3155-230037 | 4 | | |
| 27 | | Shaft extension, S2 thru S7 | 3155-240457 | 89536 | 3155-240457 | 6 | | |

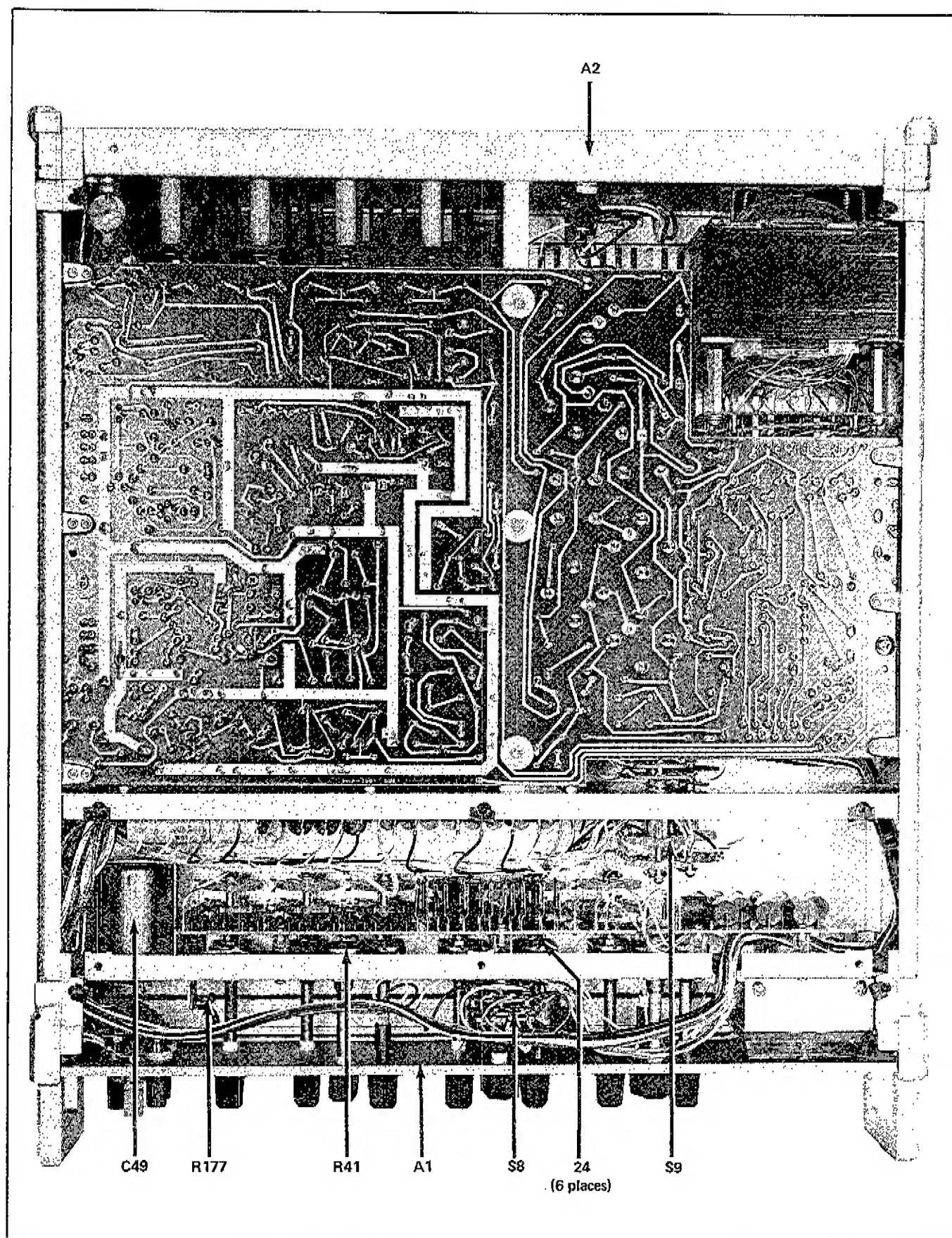


Figure 5-8. 343A DC VOLTAGE CALIBRATOR (Sheet 1 of 2)

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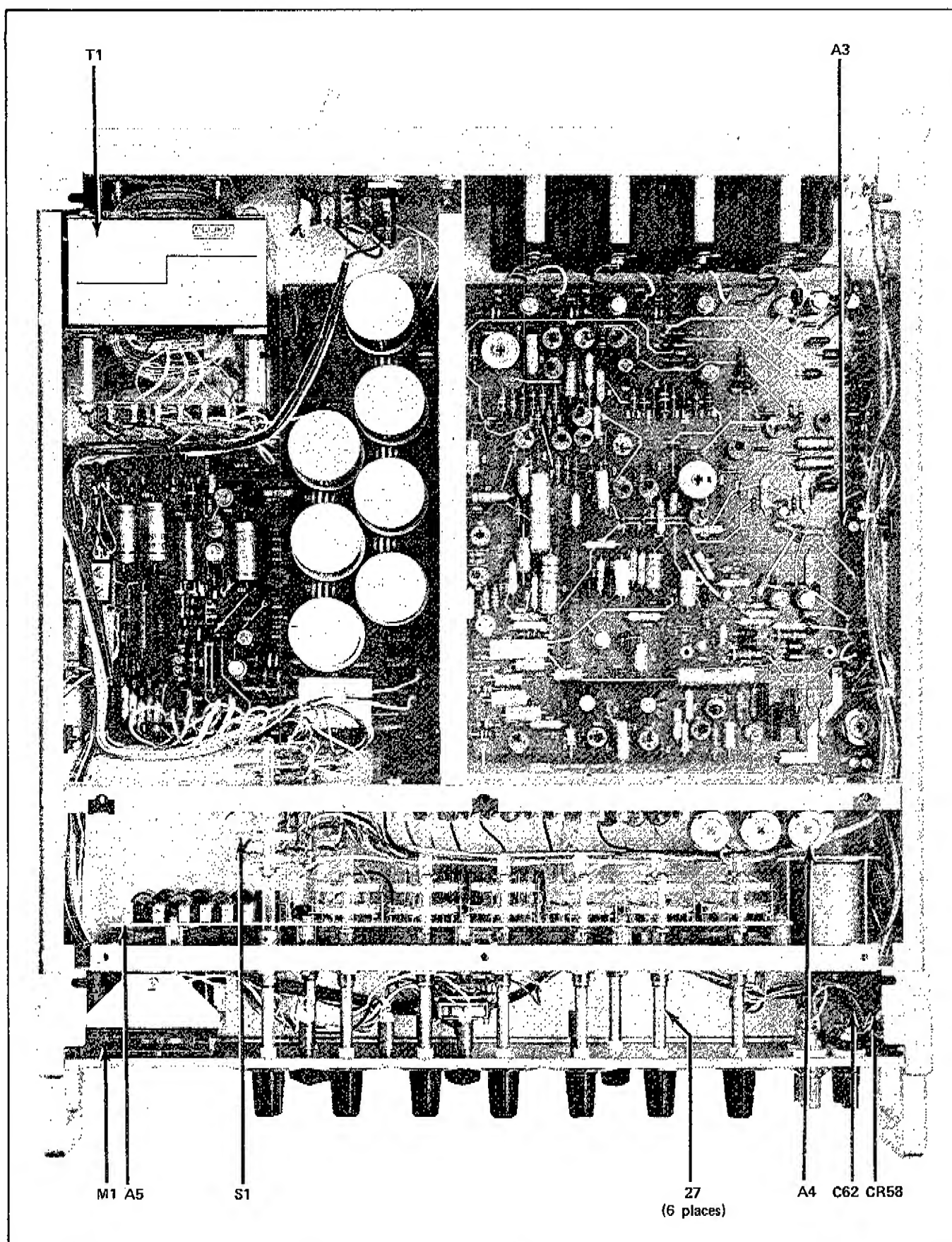


Figure 5-8. 343A DC VOLTAGE CALIBRATOR (Sheet 2 of 2)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|----------------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| A1 | | FRONT PANEL ASSEMBLY (343A) Figure 5-9 | | | | | | |
| DS3 thru DS7 | | Lamp, incandescent, 28v | 3901-246686 | 08806 | 7387 | 5 | 2 | |
| J1, J2 | | Binding post, red | 2811-226308 | 58474 | DF21RC | 2 | | |
| J3, J4 | | Binding post, black | 2811-226282 | 58474 | DF21BC | 2 | | |
| J5 | | Binding post, white | 2811-261156 | 58474 | DF21WTC | 1 | | |
| XDS3 thru XDS7 | | Holder, lamp | 3155-252411 | 89536 | 3155-252411 | 5 | | |
| 28 | | Handle | 2404-246306 | 89536 | 2404-246306 | 2 | | |
| 29 | | Knob, CURRENT LIMIT | 2405-190249 | 89536 | 2405-190249 | 1 | | |
| 30 | | Knob, DIGIT, 0-X | 3155-252353 | 89536 | 3155-252353 | 6 | | |
| 31 | | Knob, DIGIT, 0-10 | 3155-252361 | 89536 | 3155-252361 | 1 | | |
| 32 | | Knob, FUNCTION, RANGE | 2405-158956 | 89536 | 2405-158956 | 2 | | |
| 33 | | Lens, lamp, clear | 3155-222596 | 89536 | 3155-222596 | 3 | | |
| 34 | | Lens, lamp, red | 3155-228056 | 89536 | 3155-228056 | 2 | | |
| 35 | | Link, shorting | 2811-101220 | 24655 | 0938-9712 | 3 | | |
| 36 | | Panel, front | 1406-252403 | 89536 | 1406-252403 | 1 | | |

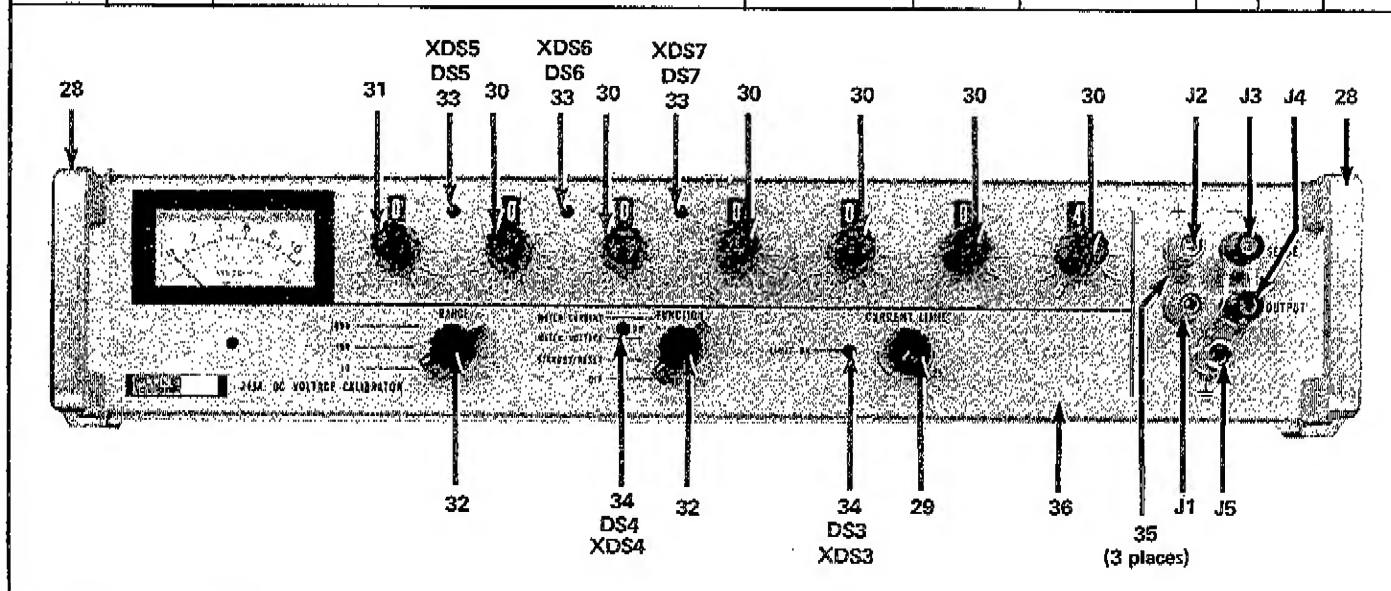


Figure 5-9. FRONT PANEL ASSEMBLY (343A)

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| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|-----------------------------|-------------|--|-------------|-------|----------------|------------|------------|-------------|
| A2 | | REAR PANEL ASSEMBLY (343A) Figure 5-10 | | | | | | |
| C59, C60 C66 | | Cap, cer, 0.01 uf +80/-20%, 500v | 1501-105668 | 56289 | 29C9B5 | 3 | | |
| F1 | | Cap, plstc, 0.1 uf ±20%, 1600v | 1507-261073 | 84411 | Type 663UW | 1 | | |
| F1 | | Fuse, slow blow, 1 amp, 250v (for 115v operation) | 5101-109272 | 71400 | Type MDL | 1 | 3 | |
| F1 | | Fuse, slow blow, 1/2 amp, 250v (for 230v operation) | 5101-109322 | 71400 | Type MDL | 1 | 3 | |
| F2 | | Fuse, slow blow, 1/16 amp, 250v | 5101-163030 | 71400 | Type MDL | 1 | 3 | |
| Q42, Q44, Q46, Q48 | | Tstr, silicon, NPN (behind heat sinks) | 4811-190710 | 04713 | 2N3739 | 4 | 4 | |
| W1 | | Line cord | 6005-226027 | 89536 | 6005-226027 | 1 | | |
| XF1, XF2 | | Holder, Fuse | 2102-160846 | 75915 | 342004 | 2 | | |
| 37 | | Heat sink | 3156-240432 | 89536 | 3156-240432 | 4 | | |
| 38 | | Panel, rear | 3156-240309 | 89536 | 3156-240309 | 1 | | |

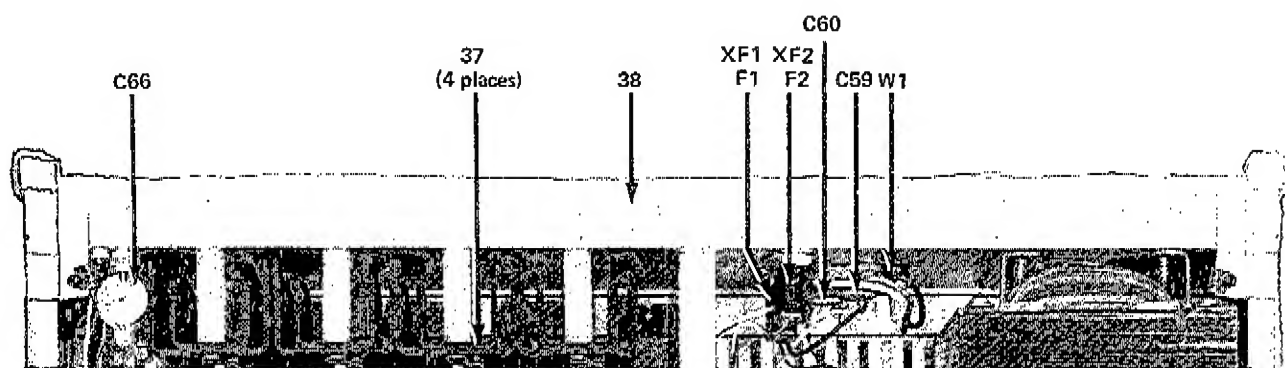















Figure 5-10. REAR PANEL ASSEMBLY (343A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|--|-------|----------------|------------|------------|-------------|
| A4 | | REFERENCE P/C ASSEMBLY Figure 5-11 NOTE: The Reference P/C Assembly (A4), the Sample String P/C Assembly (A5) and their inter-matched resistors can be ordered under one part number, 3158-265314. | 3158-252437 | 89536 | 3158-252437 | REF | | |
| C1 | | Cap, plstc, 0.1 uf $\pm 10\%$, 1, 200v | 1507-233718 | 84411 | JF15 | 2 | | |
| C2 | | Cap, plstc, 0.1 uf $\pm 10\%$, 1, 200v | 1507-233718 | 84411 | JF15 | REF | | |
| R1 | | Res, var, cermet, 1k $\pm 20\%$, 3/4w | 4713-190538 | 73138 | Type 78P | 1 | | |
| R2 | | Res, ww, 1.4995M, matched |  | | | | | |
| R3 | | Res, var, cermet, 100 Ω $\pm 20\%$, 3/4w | 4713-159889 | 73138 | Type 78P | 3 | | |
| R4 | | Res, ww, 149.95k, matched |  | | | | | |
| R5 | | Res, var, cermet, 100 Ω $\pm 20\%$, 3/4w | 4713-159889 | 73138 | Type 78P | REF | | |
| R6 | | Res, met flm, 200 Ω $\pm 0.5\%$, 1/2w | 4705-246248 | 19701 | Type MF7C | 1 | | |
| R7 | | Res, met flm, 200 Ω , $\pm 1\%$, 1/2w | 4705-151480 | 19701 | Type MF7C | 1 | | |
| R8 | | Res, ww, 14.9286k, matched |  | | | | | |
| R9 | | Res, ww, 99.955k, matched |  | | | | | |
| R10 | | Res, ww, 99.955k, matched |  | | | | | |
| R11 | | Res, var, cermet, 200 Ω $\pm 20\%$, 3/4w | 4713-186213 | 73138 | Type 78P | 5 | | |
| R12 | | Res, ww, 99.955k, matched |  | | | | | |
| R13 | | Res, ww, 99.955k, matched |  | | | | | |
| R14 | | Res, var, cermet, 200 Ω $\pm 20\%$, 3/4w | 4713-186213 | 73138 | Type 78P | REF | | |
| R15 | | Res, ww, 99.955k, matched |  | | | | | |
| R16 | | Res, ww, 99.955k, matched |  | | | | | |
| R17 | | Res, var, cermet, 200 Ω $\pm 20\%$, 3/4w | 4713-186213 | 73138 | Type 78P | REF | | |
| R18 | | Res, ww, 99.955k, matched |  | | | | | |
| R19 | | Res, ww, 99.955k, matched |  | | | | | |
| R20 | | Res, var, cermet, 200 Ω $\pm 20\%$, 3/4w | 4713-186213 | 73138 | Type 78P | REF | | |
| R21 | | Res, ww, 99.955k, matched |  | | | | | |
| R22 | | Res, ww, 99.955k, matched |  | | | | | |

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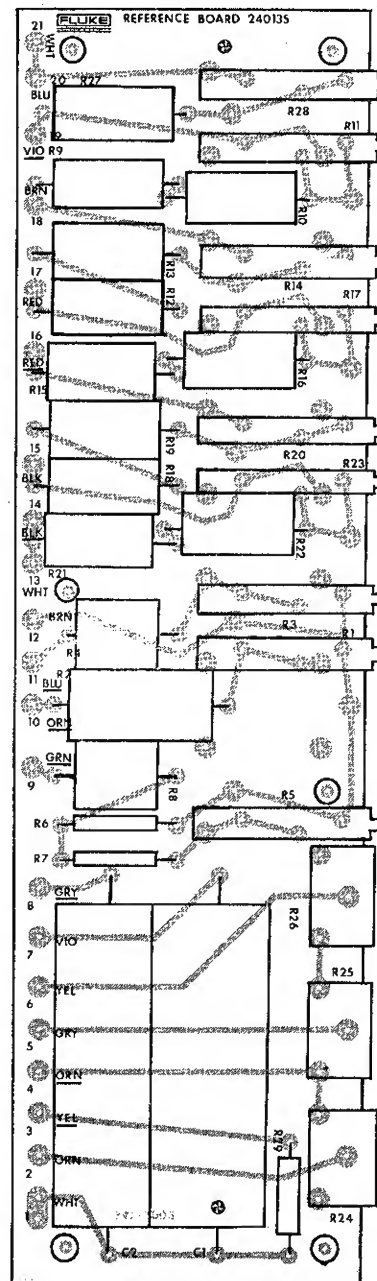





















Figure 5-11. REFERENCE P/C ASSEMBLY (343A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|---|--|-------|----------------|------------|------------|-------------|
| R23 | | Res, var, cermet, $200\Omega \pm 20\%$, 3/4w | 4713-186213 | 73138 | Type 78P | REF | | |
| R24 | | Res, var, ww, $10k \pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | 3 | | |
| R25 | | Res, var, ww, $10k \pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | REF | | |
| R26 | | Res, var, ww, $10k \pm 10\%$, 1-1/4w | 4702-162115 | 71450 | Type 110 | REF | | |
| R27 | | Res, ww, 99.955k, matched |  | | | | | |
| R28 | | Res, var, cermet, $100\Omega \pm 20\%$, 3/4w | 4713-159889 | 73138 | Type 78P | REF | | |
| R29 | | Res, comp, $330k \pm 5\%$, 1w | 4704-109777 | 01121 | GB3345 | 1 | | |



R2, R4, R8, R9/R10, R12/R13, R15/R16, R18/R19, R21/R22, R27 and A5R1, A5R4, A5R5, A5R8, A5R9, and A5R12 thru A5R25 are an intermatched resistor set, part number 4710-265330. The resistors may be replaced individually by giving model, serial number, full reference designation, and all markings on the old resistor. However, R9/R10, R12/R13, R15/R16, R18/R19 and R21/R22 must be ordered and replaced in pairs.

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|--|-------|----------------|------------|------------|-------------|
| A5 | | SAMPLE STRING P/C ASSEMBLY Figure 5-12 NOTE: The Reference P/C Assembly(A4), the Sample String P/C Assembly (A5) and their intermatched re- sistors can be ordered under one part number, 3158-265314. | 3158-252429 | 89536 | 3158-252429 | REF | | |
| CR1 | | Diode, silicon, 200 ma, 25 piv | 4805-190272 | 93332 | IN456A | 2 | | |
| CR2 | | Diode, silicon, 200 ma, 25 piv | 4805-190272 | 93332 | IN456A | REF | | |
| R1 | | Res, ww, 19.991k, matched |  | | | | | |
| R2 | | Res, var, cermet, 20Ω ±30%, 3/4w | 4713-186197 | 73138 | Type 78P | 5 | | |
| R3 | | Res, var, cermet, 20Ω ±30%, 3/4w | 4713-186197 | 73138 | Type 78P | REF | | |
| R4 | | Res, ww, 19.991k, matched |  | | | | | |
| R5 | | Res, ww, 19.991k, matched |  | | | | | |
| R6 | | Res, var, cermet, 20Ω ±30%, 3/4w | 4713-186197 | 73138 | Type 78P | REF | | |
| R7 | | Res, var, cermet, 20Ω ±30%, 3/4w | 4713-186197 | 73138 | Type 78P | REF | | |
| R8 | | Res, ww, 19.991k, matched |  | | | | | |
| R9 | | Res, ww, 19.991k, matched |  | | | | | |
| R10 | | Res, var, cermet, 20Ω ±30%, 3/4w | 4713-186197 | 73138 | Type 78P | REF | | |
| R11 | | Res, var, cermet, 10Ω ±30%, 3/4w | 4713-186205 | 73138 | Type 78P | 1 | | |
| R12 | | Res, ww, 19.991k, matched |  | | | | | |
| R13 | | Res, ww, 19.991k, matched |  | | | | | |
| R14 | | Res, ww, 2k, matched |  | | | | | |
| R15 | | Res, ww, 2k, matched |  | | | | | |
| R16 | | Res, ww, 2k, matched |  | | | | | |
| R17 | | Res, ww, 2k, matched |  | | | | | |
| R18 | | Res, ww, 2k, matched |  | | | | | |
| R19 | | Res, ww, 1k, matched |  | | | | | |
| R20 | | Res, ww, 200Ω, matched |  | | | | | |
| R21 | | Res, ww, 200Ω, matched |  | | | | | |
| R22 | | Res, ww, 200Ω, matched |  | | | | | |
| R23 | | Res, ww, 200Ω, matched |  | | | | | |
| R24 | | Res, ww, 200Ω, matched |  | | | | | |

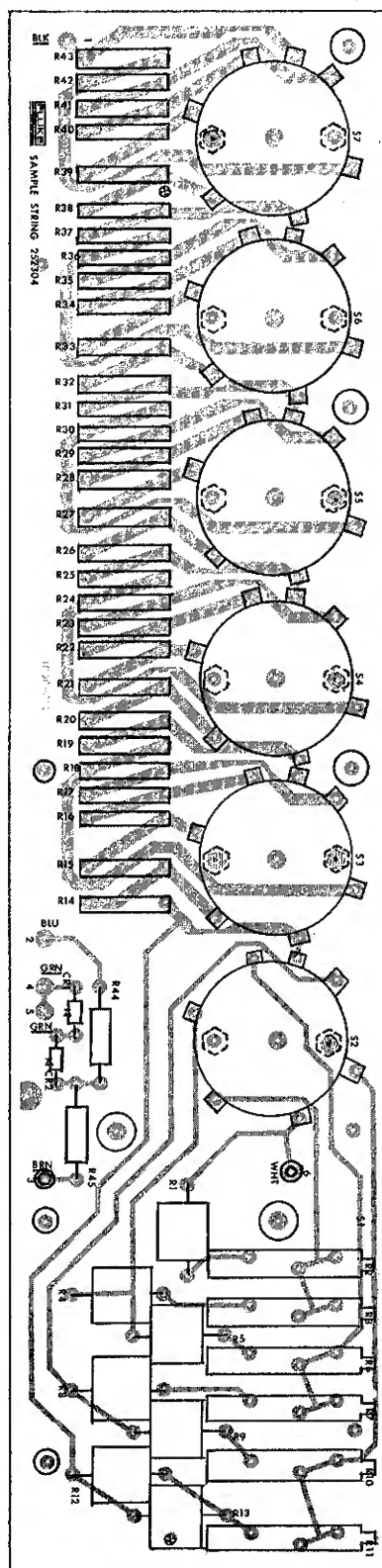




Figure 5-12. SAMPLE STRING P/C ASSEMBLY (343A)

| REF DESIG | INDEX NO | DESCRIPTION | STOCK NO | MFR | MFR PART NO | TOT QTY | REC QTY | USE CODE |
|--------------|-------------|--|---|-------|----------------|------------|------------|-------------|
| R25 | | Res, ww, 100 Ω , matched |  | | | | | |
| R26 | | Res, ww, 20 Ω \pm 0.25%, 0.7w | 4707-255620 | 01686 | Type T2 | 5 | | |
| R27 | | Res, ww, 20 Ω \pm 0.25%, 0.7w | 4707-255620 | 01686 | Type T2 | REF | | |
| R28 | | Res, ww, 20 Ω \pm 0.25%, 0.7w | 4707-255620 | 01686 | Type T2 | REF | | |
| R29 | | Res, ww, 20 Ω \pm 0.25%, 0.7w | 4707-255620 | 01686 | Type T2 | REF | | |
| R30 | | Res, ww, 20 Ω \pm 0.25%, 0.7w | 4707-255620 | 01686 | Type T2 | REF | | |
| R31 | | Res, ww, 10 Ω \pm 0.25%, 0.7w | 4707-255638 | 01686 | Type T2 | 1 | | |
| R32 | | Res, ww, 2 Ω \pm 1%, 0.7w | 4707-255646 | 01686 | Type T2 | 5 | | |
| R33 | | Res, ww, 2 Ω \pm 1%, 0.7w | 4707-255646 | 01686 | Type T2 | REF | | |
| R34 | | Res, ww, 2 Ω \pm 1%, 0.7w | 4707-255646 | 01686 | Type T2 | REF | | |
| R35 | | Res, ww, 2 Ω \pm 1%, 0.7w | 4707-255646 | 01686 | Type T2 | REF | | |
| R36 | | Res, ww, 2 Ω \pm 1%, 0.7w | 4707-255646 | 01686 | Type T2 | REF | | |
| R37 | | Res, ww, 1 Ω \pm 1%, 0.7w | 4707-255653 | 01686 | Type T2 | 1 | | |
| R38 | | Res, ww, 0.2 Ω \pm 3%, 0.7w | 4707-255661 | 01686 | Type T2 | 5 | | |
| R39 | | Res, ww, 0.2 Ω \pm 3%, 0.7w | 4707-255661 | 01686 | Type T2 | REF | | |
| R40 | | Res, ww, 0.2 Ω \pm 3%, 0.7w | 4707-255661 | 01686 | Type T2 | REF | | |
| R41 | | Res, ww, 0.2 Ω \pm 3%, 0.7w | 4707-255661 | 01686 | Type T2 | REF | | |
| R42 | | Res, ww, 0.2 Ω \pm 3%, 0.7w | 4707-255661 | 01686 | Type T2 | REF | | |
| R43 | | Res, ww, 0.1 Ω \pm 3%, 0.7w | 4707-255679 | 01686 | Type T2 | 1 | | |
| R44 | | Res, met flm, 4.99k \pm 1%, 1/2w | 4705-148890 | 19701 | Type MF7C | 1 | | |
| R45 | | Res, met flm, 3.16k \pm 1%, 1/2w | 4705-187781 | 19701 | Type MF7C | 1 | | |
| S2 | | Switch, rotary, Decade 2 | 5105-257253 | 89536 | 5105-257253 | 6 | | |
| S3 | | Switch, rotary, Decade 3 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S4 | | Switch, rotary, Decade 4 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S5 | | Switch, rotary, Decade 5 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S6 | | Switch, rotary, Decade 6 | 5105-257253 | 89536 | 5105-257253 | REF | | |
| S7 | | Switch, rotary, Decade 7 | 5105-257253 | 89536 | 5105-257253 | REF | | |



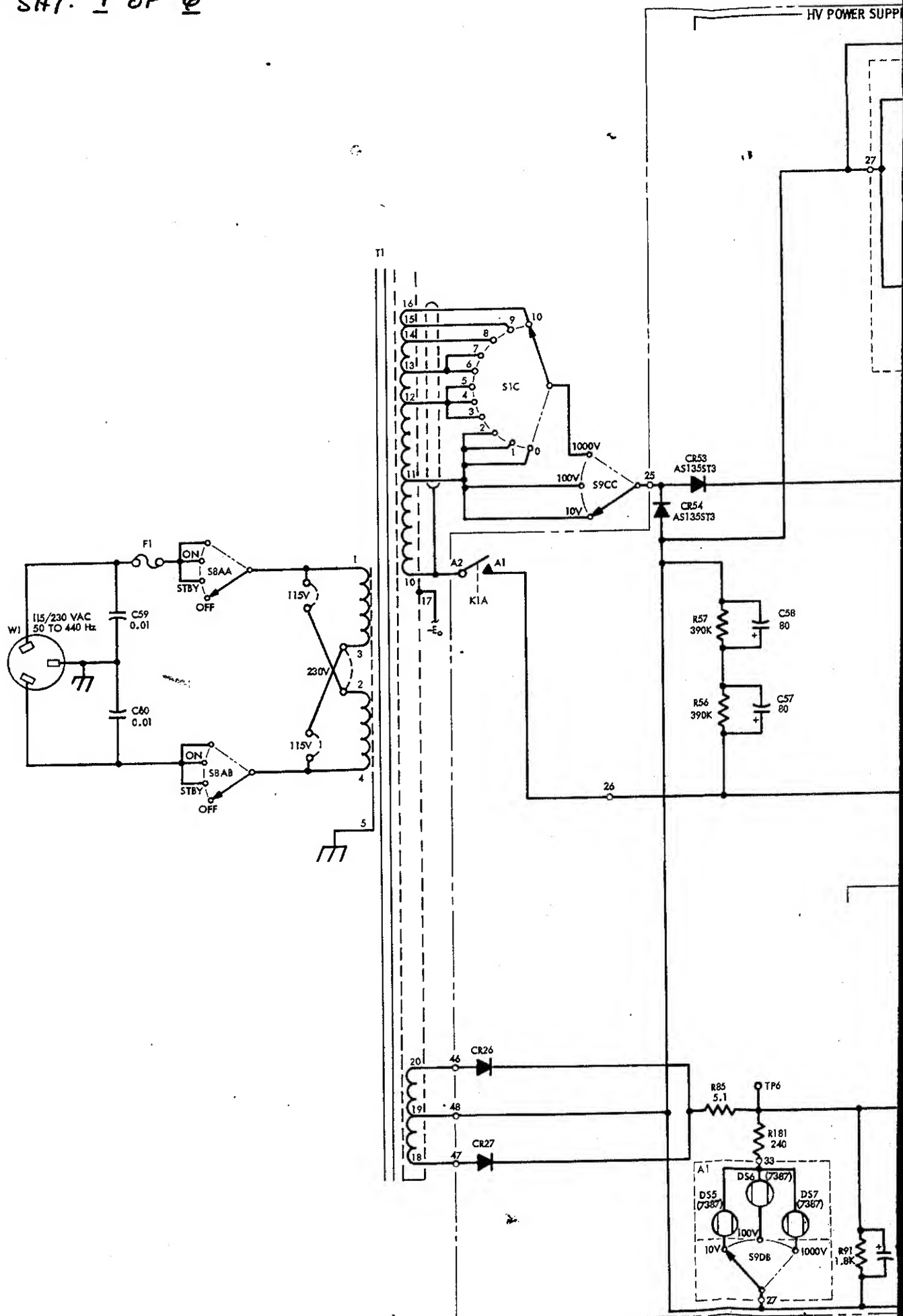
R1, R4, R5, R8, R9 and R12 thru R25 are part of an intermatched resistor set, part number 4710-265330 (See , page 5-41). The resistors may be replaced individually by giving model, serial number, full reference designation, and all markings on the old resistor. However, R12/R13 must be ordered and replaced as a pair.

5-9. SERIAL NUMBER EFFECTIVITY

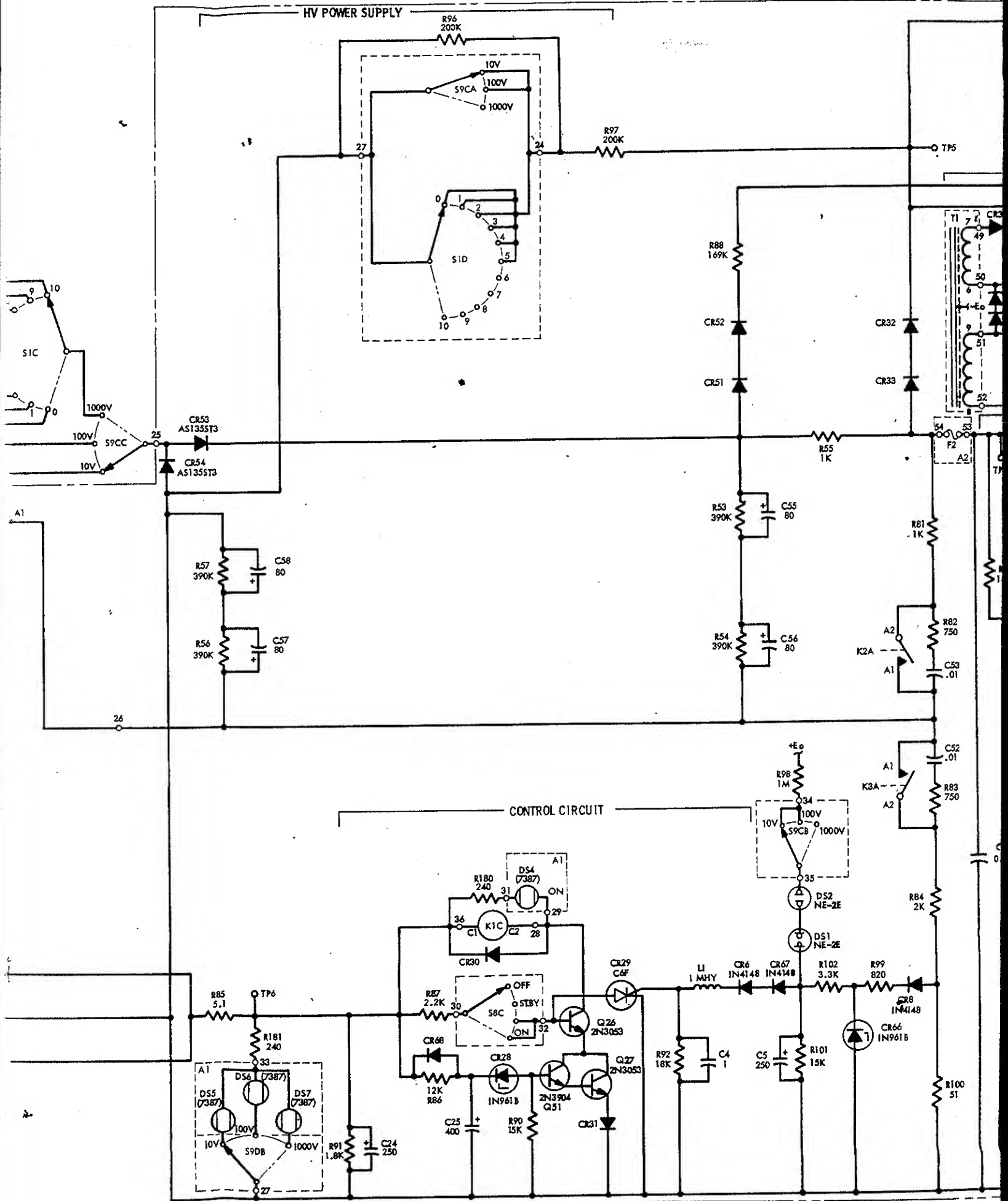
5-10. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the Model 341A and 343A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List below. All parts with no code are used on all instruments with serial numbers above 123.

| USE CODE | EFFECTIVITY |
|-------------|--------------------------------------|
| NO | Model 341A serial number 123 and on. |
| CODE | Model 343A serial number 123 and on. |

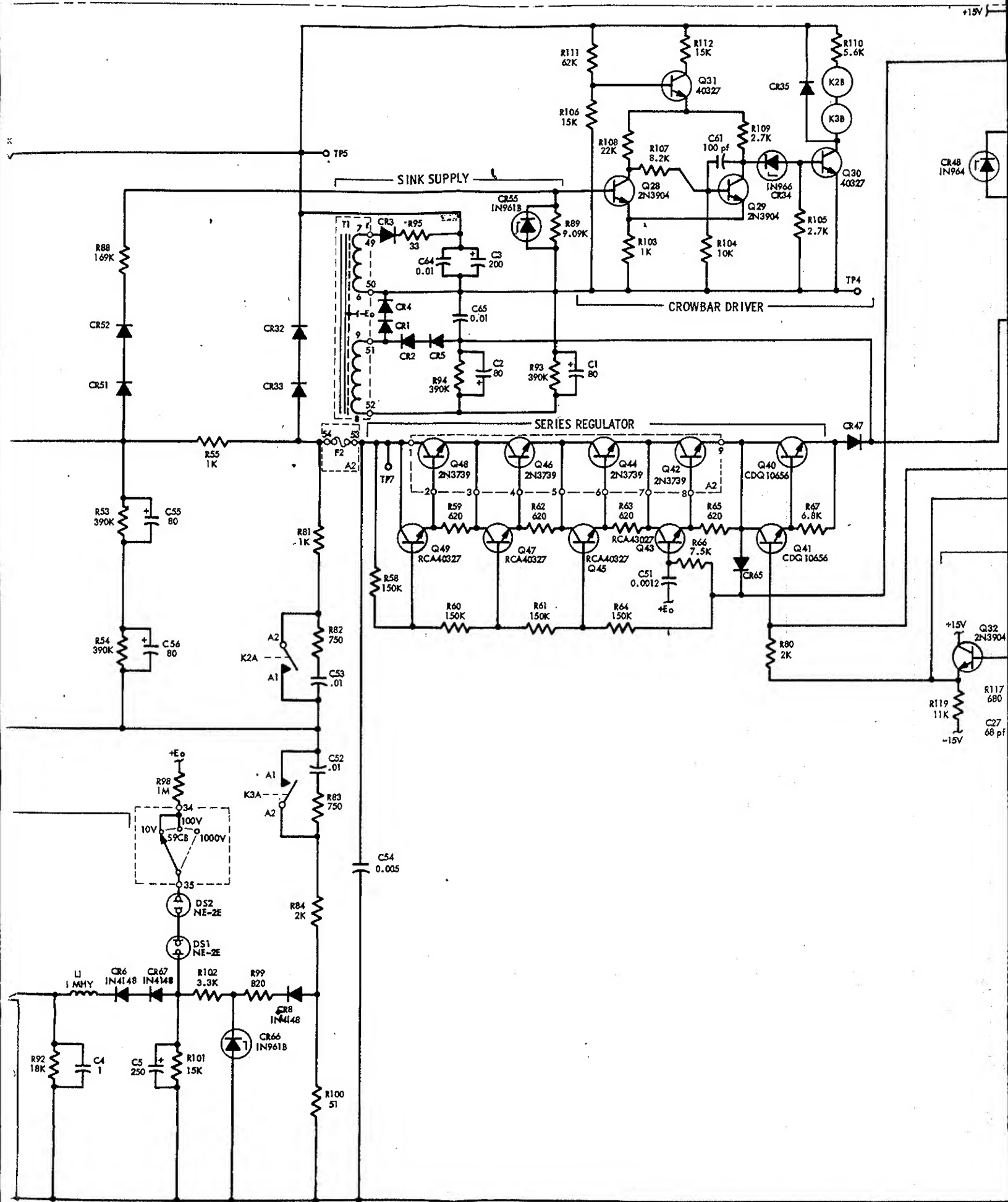
SCHEM. NO. 1
 SH. 1 OF 6



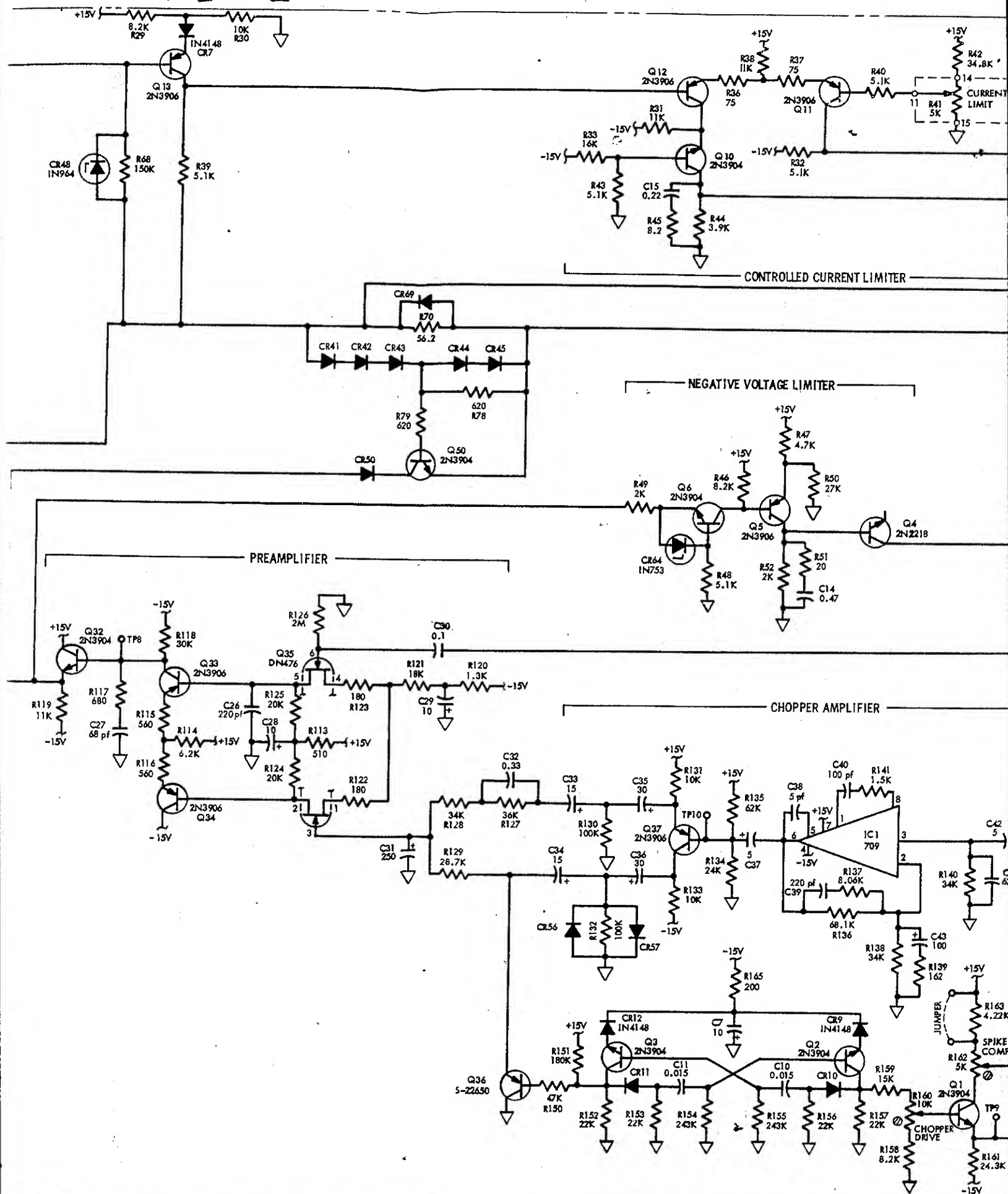
SCHEM. NO 1
SHT. 2 OF 6

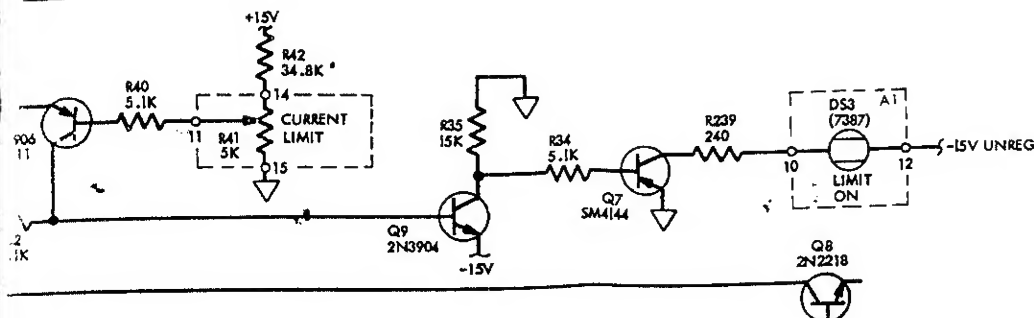


SHT. 3 OF 6



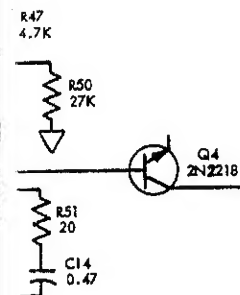
SCHEM. NO. 1
SHT. 1 OF 2



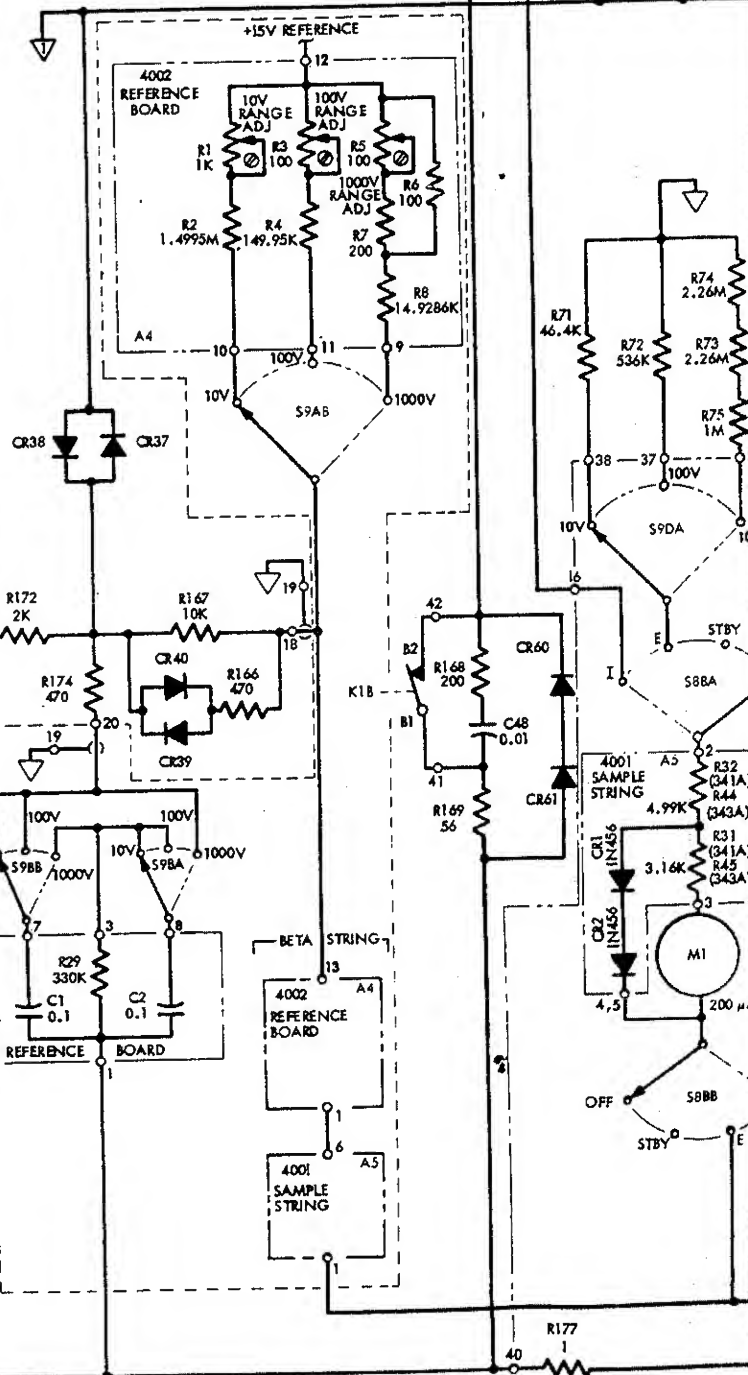
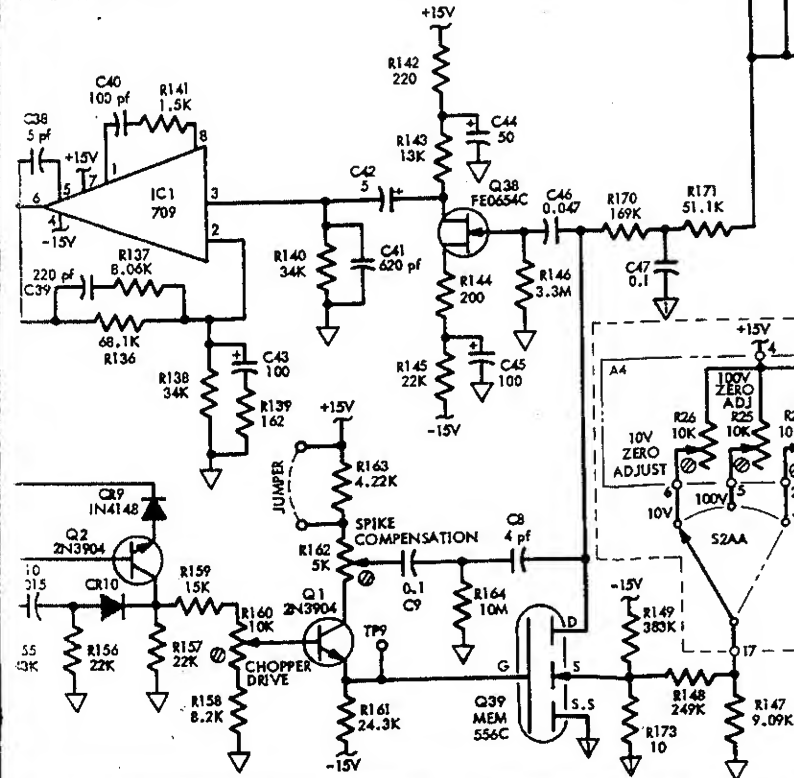


ED CURRENT LIMITER

LIMITER



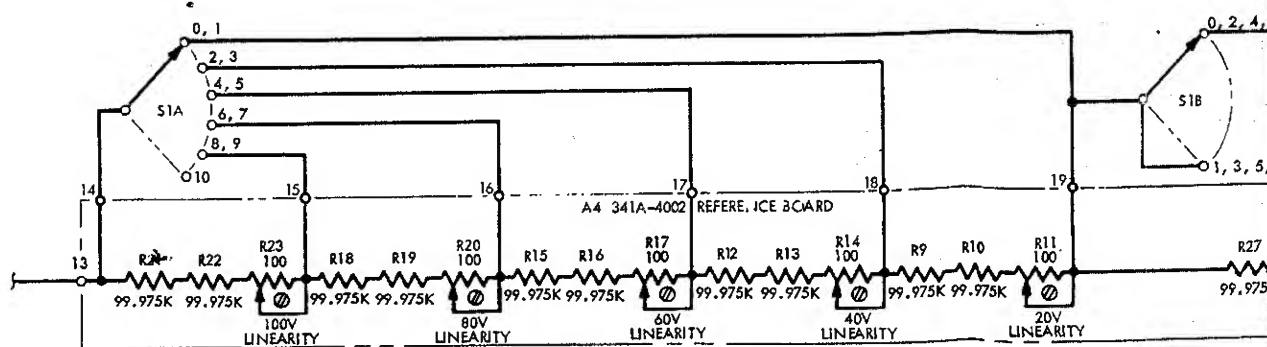
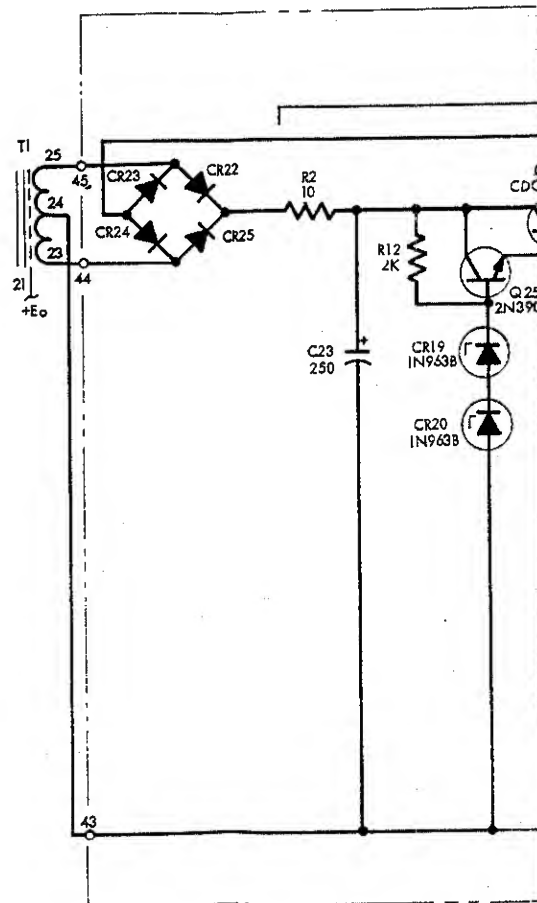
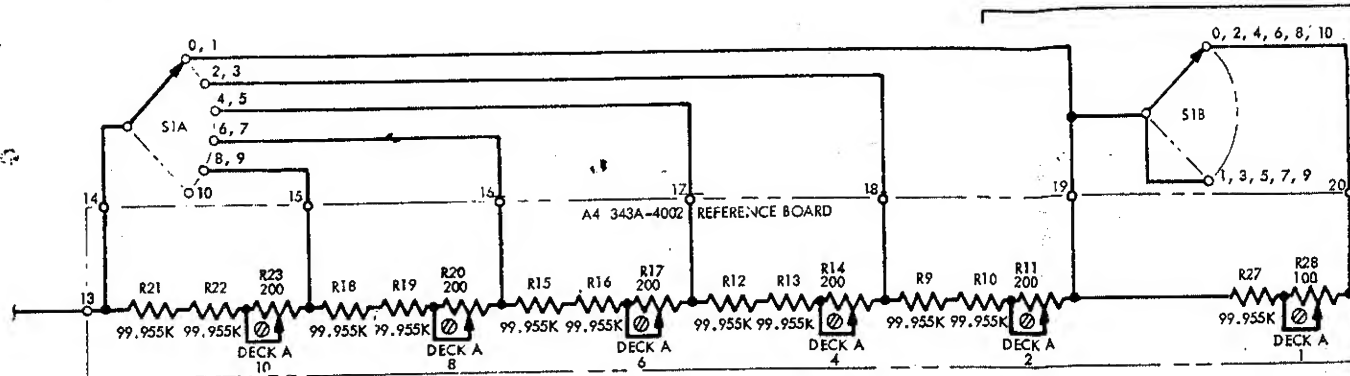
OPPER AMPLIFIER



SHT. 6 OF 6

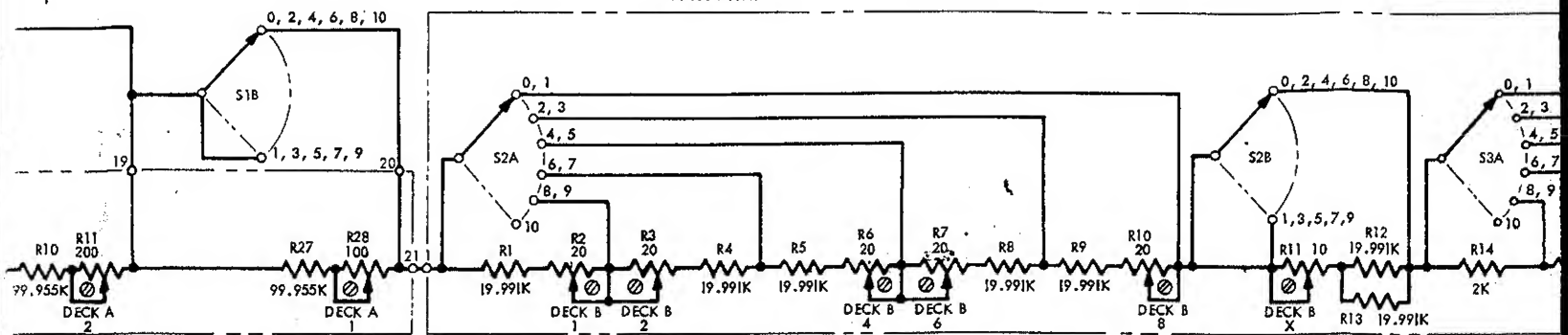


SCHEM. NO. 2
SHT. 1 OF 5

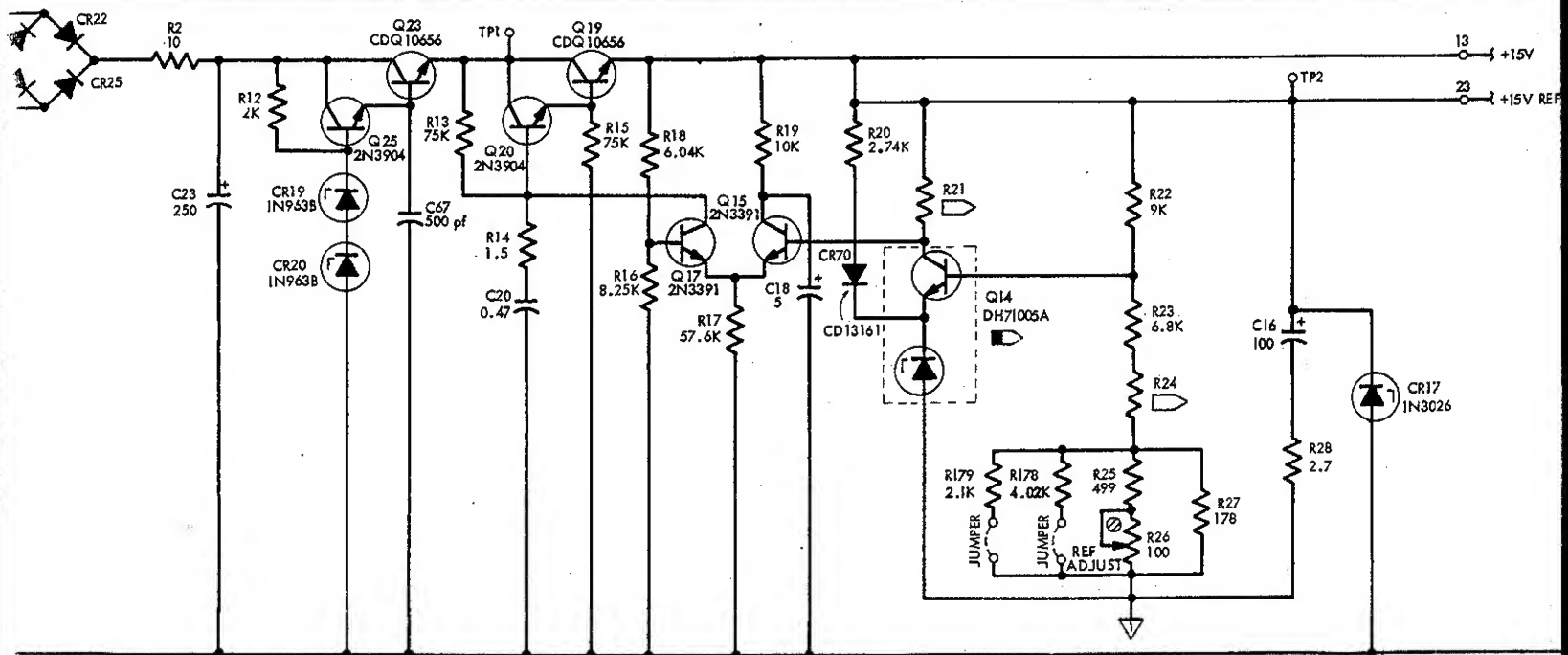


SCHEM. NO. 2
SHT. 2 OF 5

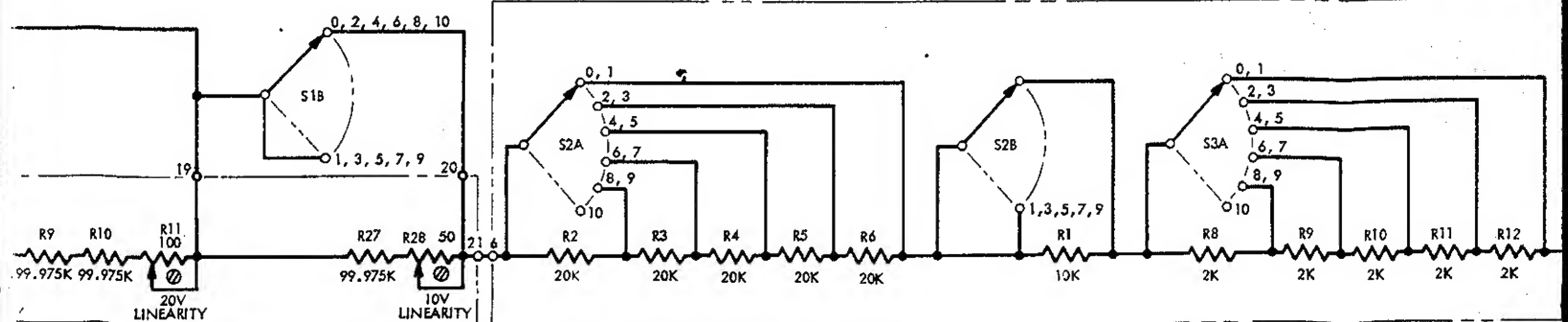
BETA STRING



+15 VOLT REFERENCE SUPPLY

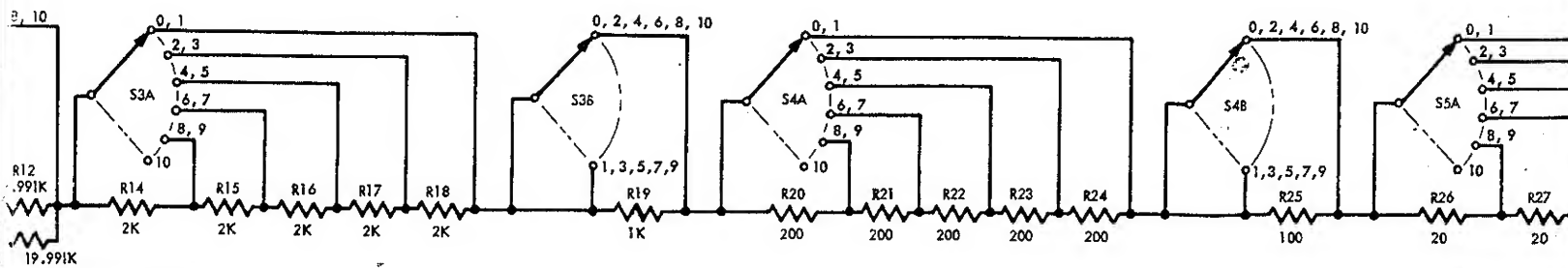


BETA STRING

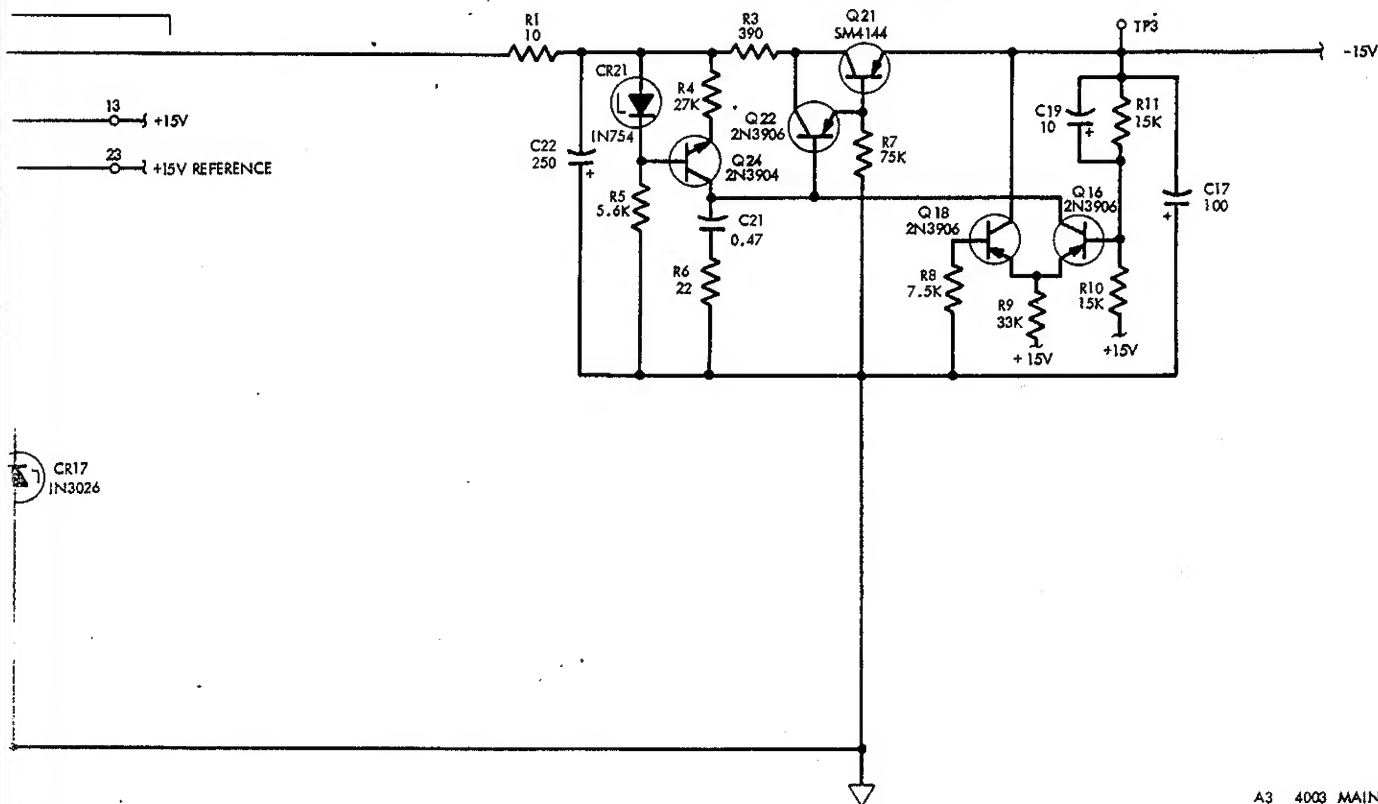


SCHEM. NO. 2
SHT 3 OF 5

A5 343A-4001 SAMPLE STRING

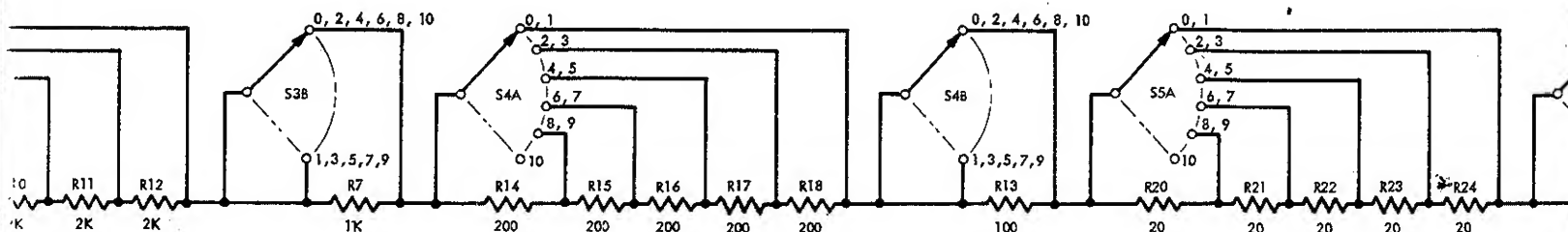


-15 VOLT AUXILIARY SUPPLY



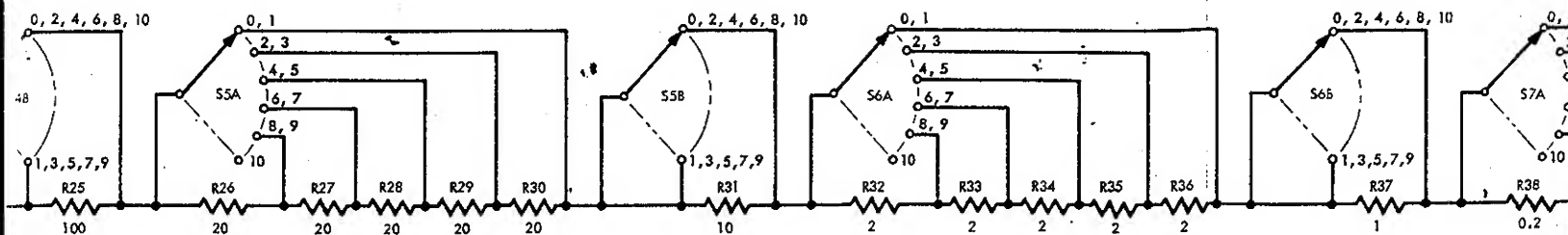
A3 4003 MAINBOARD

A5 341A-4001 SAMPLE STRING

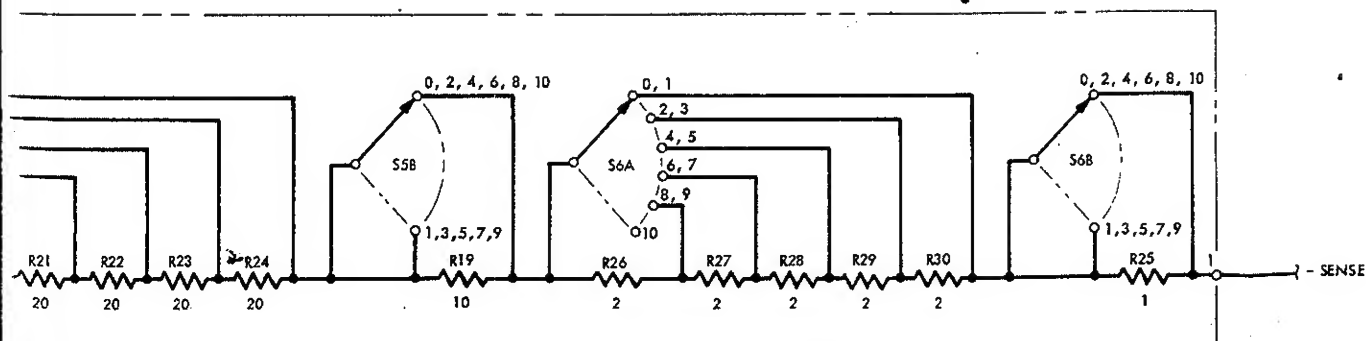


SCHEM. NO 2

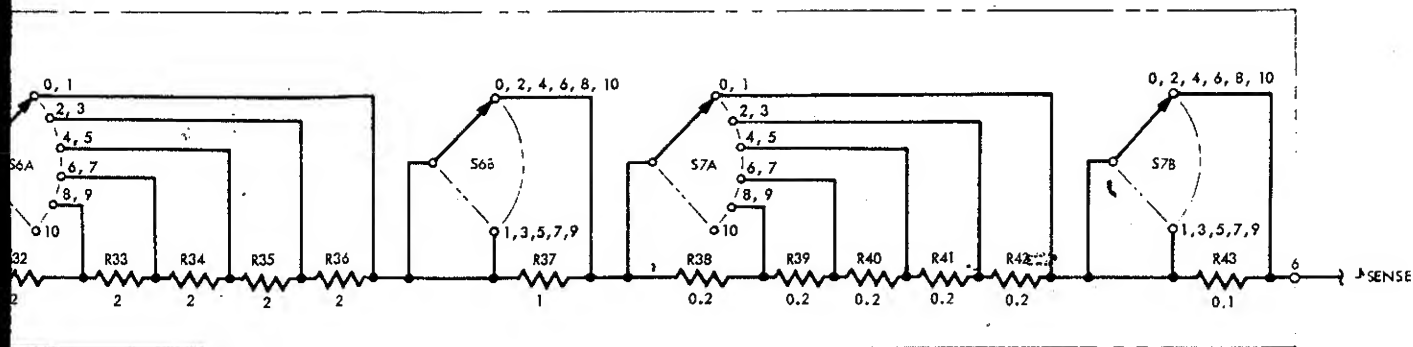
SHT 4 OF 5



4003 MAINBOARD



SCHEM. NO. 2
SHT. 5 OF 5



NOTES:

ALL RESISTANCES IN OHMS UNLESS OTHERWISE AS NOTED.
ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE AS NOTED

◻ SELECTED WITH Q14

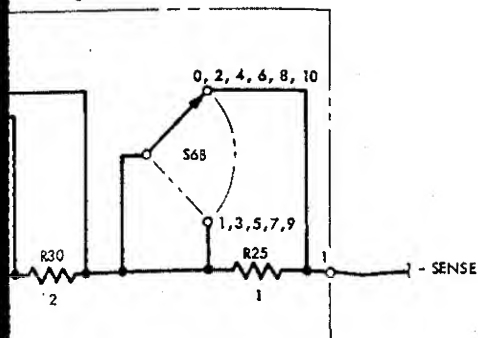
◼ DENOTES FACTORY SELECTED COMPONENT

▽ DENOTES + SENSE

▽ DENOTES CIRCUIT GROUND

⊙ DENOTES INTERNAL ADJUSTMENT

--- DENOTES ASSEMBLY



| | |
|--|-----|
| FUNCTIONAL SCHEMATIC DIAGRAM | |
| MODEL 341A/MODEL 343A | |
| DC VOLTAGE CALIBRATOR | |
| SCHEMATIC NO. 2 | |
| SER. NO. 123 & ON | REV |
| JOHN FLUKE MFG. CO., INC. P.O. Box 7428 Seattle, Washington 98133 | |